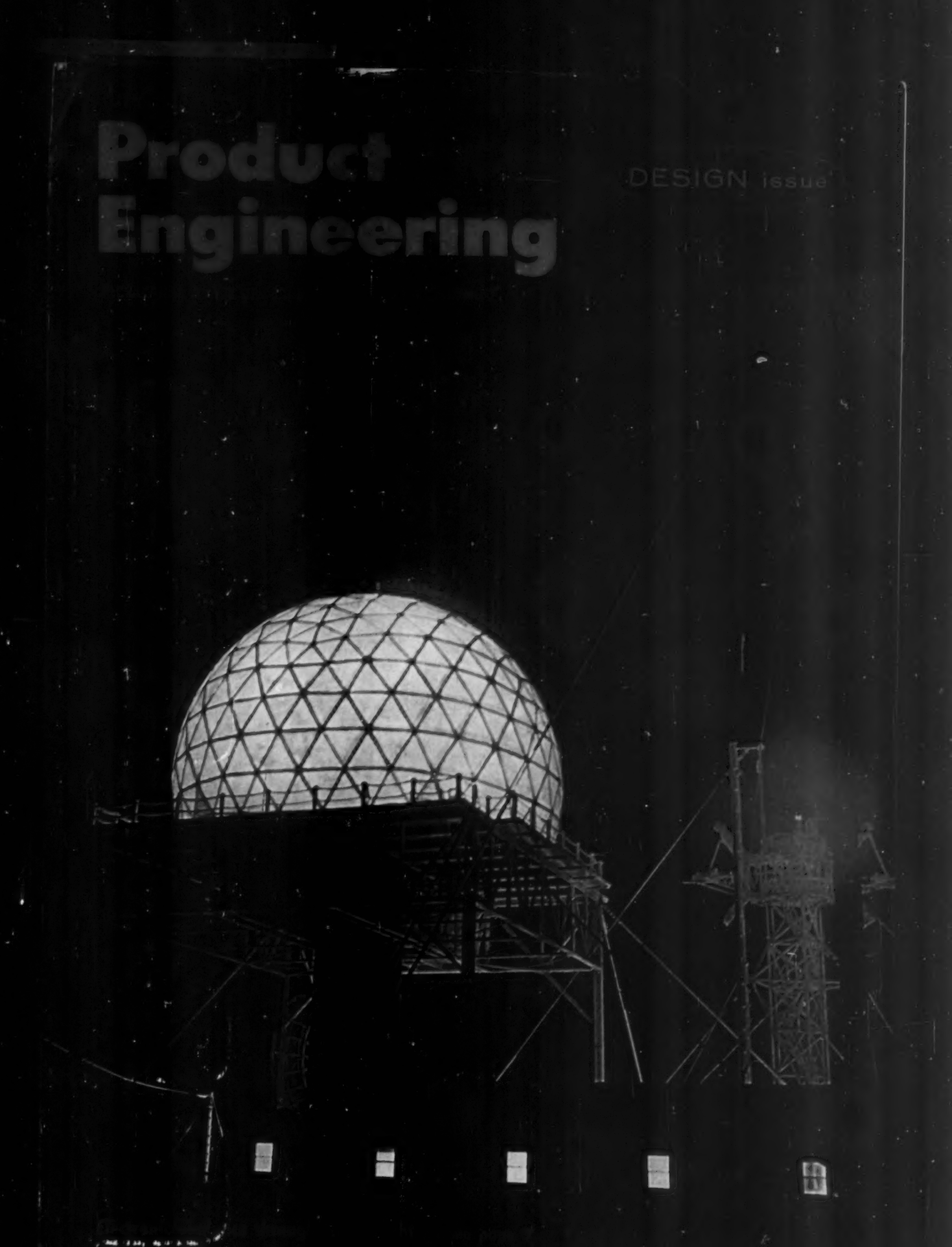
Product Engineering

DESIGN issue



Now you can get standard sizes in C/R End Face Seals!

Chicago Rawhide now announces the availability of a complete new line of Standard End Face Seals to meet the widest possible range of sealing requirements. For sizes or conditions beyond the range of Standard End Face Seals, C/R engineers will continue to cooperate with you on special designs. Their experience in sealing applications is unmatched — your assurance of getting the correct seal for the job.

Write for your free copy of this new C/R Bulletin →

Bulletin EF-100 includes complete envelope space data on C/R Standard End Face Seals and mating rings to help you select the correct size for your equipment design:

- Size range table in two series — long and short — from ¾ to 4 inch shaft diameter.
- Size range table on mating rings.
- Typical seal installations for internal and external pressure.
- Special instructions on how to order.

C/R
STANDARD
END FACE SEALS
maximum sealing efficiency in minimum space
• ¾ to 4 inch shaft sizes
• pressures to 500 psi
• temperatures to 500° F.
• peripheral speeds to 15,000 FPM.
• external or internal pressures
2 complete series — long and short — pre-engineered to meet the widest possible range of sealing requirements. Standard mating rings also available.
Special End Face Seals...
1301 Elston Avenue
Chicago 22, Illinois

C/R OIL SEAL DIVISION

CHICAGO RAWHIDE

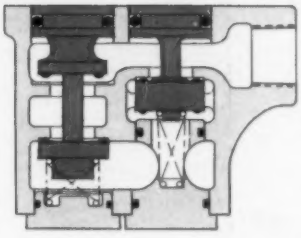
CHICAGO RAWHIDE MANUFACTURING COMPANY
1237 ELSTON AVENUE • CHICAGO 22, ILLINOIS
Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario.
Export Sales: Geon International Corp., Great Neck, New York

C/R PRODUCTS: C/R Shaft and End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-Metallic Gears

CIRCLE NO. 201 READER SERVICE CARD

a basic Ross *valve building block*

4-way inline mounted valve body



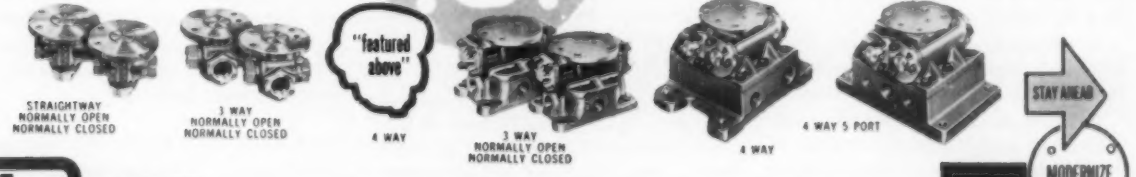
- **Compact—saves space**
- **Ross quality**
- **Costs much less than base mounted 4-way**

Lots of designers use this valve where they must save space. It was designed specifically for compactness! Others use it to save money *without sacrificing* quality—when J.I.C. allows the usage of an inline valve, it meets J.I.C. specs. It's a unit of the Ross Skyline series which features modular construction, so it can be actuated with any Skyline series head. Ross poppet construction means pressure assists the seal, and short poppet travel gives faster response. On most applications it outlives the machine—and frequently doesn't even require maintenance. Write for Bulletin 321.

* WHITEMODEL SPOOL SOLENOID
* GOLDMODEL OIL-IMMERSED SOLENOID
* SILVERMODEL JIC SPOOL SOLENOID
GREENMODEL DOUBLE SOLENOID MOMENTARY
BLUEMODEL AIR OPERATED
BLUEMODEL AIR-OPERATED MOMENTARY ADAPTOR
BLUEMODEL AIR OPERATED TIMED IN
BLUEMODEL AIR-OPERATED TIMED-OUT
*THIS AIR INDEX ADAPTOR CONVERTS THESE HEADS TO MOMENTARY ACTION

"every head meets every body at this gasket"

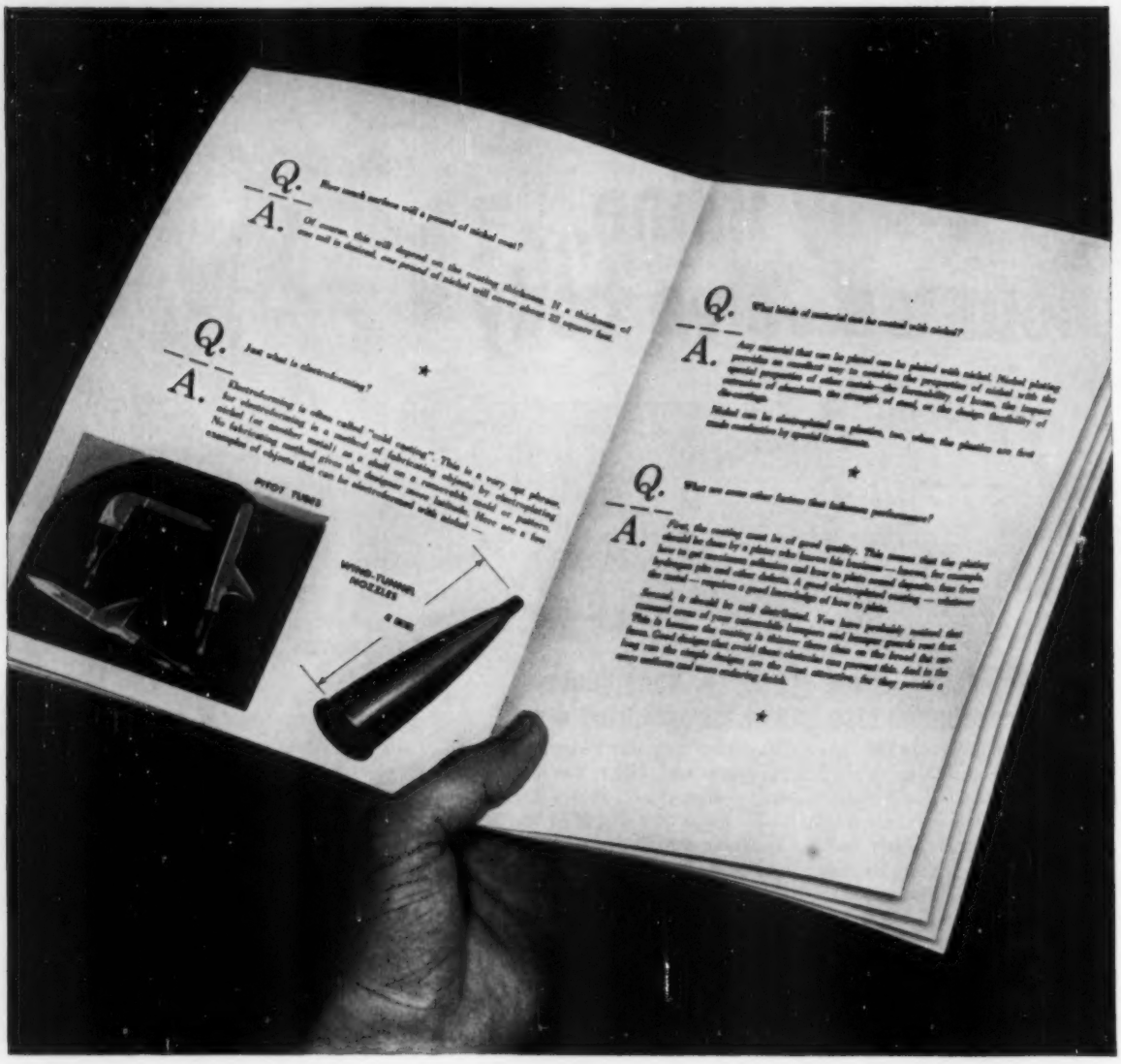
ALL SKYLINE HEADS AND BODIES ARE BUILDING BLOCKS TO GIVE YOU MANY VALVES FROM A FEW HEADS AND BODIES



ROSS OPERATING VALVE COMPANY

114 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

CIRCLE NO. 1 READER SERVICE CARD



New booklet reveals...

eye-opening facts on Nickel plating

Just leaf through two or three pages and right off you'll realize that this new booklet on Nickel plating fills a long-felt need.

It's not a how-to-do-it manual. Not a technical paper on processes. Not a sales blurb. **It's an idea generator!**

It contains 40 eye-opening facts that cover every important phase of Nickel plating – facts that may give you an entirely fresh viewpoint on this useful process.

For example, it discusses how manufacturers may cut fabrication costs by using sheet, strip—even pipe and tubing—that has been preplated with Nickel...how plated surfaces can be "made-to-order" because Nickel can be plated as thin as a breath or as thick as you would want . . .

What's more, it illustrates many of the parts that can be formed at less cost by electroforming or "cold casting"...how Nickel can be plated even on many non-metals...how more uniform coatings on complicated shapes can often be achieved by the new electroless processes.

Tips on designing for better plating are also packed into this easy-to-read, 24-page booklet. Called "Practical Answers to 40 Practical Questions about Nickel Plating," it's yours for the asking. Just drop us a postcard for your free copy.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

Inco Nickel

makes plating perform better, longer

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN RESEARCH AND DEVELOPMENT

DESIGN issue

July 20, 1959 Vol. 30, No. 29

FEATURED:

DEPARTMENTS:

INTERESTING TO NOTE 5
DEVELOPMENTS TO WATCH 19
THE ENGINEERING WEEK 21
COMING EVENTS 25
READER TO EDITOR 26
HORIZONS 45
PRODUCT DESIGNS 52
SIGNIFICANT COMPONENTS 73
CATALOGS AND BULLETINS 99
CURRENT REPRINTS 119
DESIGN ABSTRACTS 123
NEW BOOKS 125
ADVERTISERS INDEX 130
READER SERVICE CARDS 133

REPORT ON THE SOVIET EXHIBITION . . . *by the editors of Product Engineering*
Special feature reporting on and evaluating USSR designs 21

FILAMENT-WINDING GROWS UP . . . *H L Debusk and W R McCarthy*
High-speed method of reinforcing plastics is ready for more work 46

TIGHTER INVESTMENT-CAST TOLERANCES . . . *H Matthieson, Arwood Precision Casting*
How design can get those critical dimensions 49

ACOUSTOELASTICITY—A NEW TECHNIQUE . . . *Dr R W Benson and V J Raelson*
Polarized sound waves give an important new way to analyze stress 56

PRESSURE LOSSES IN BRANCH FITTINGS . . . *C M Daniels and H A Felton*
For hydraulics design—curves give losses at mainline takeoffs 60

FIND EQUATIONS IN SCATTERED DATA . . . *W J Hill, Ford Instrument Co*
Regression analysis—what it is, how the statistical tool works 62

29 BLIND-SIDE FASTENERS . . . *Federico Strasser*
In this roundup are commercial and home-made devices 66

FIELDS OF INTEREST REPRESENTED IN DEPARTMENTS:

MATERIALS:

New polyethylene rubber offers better properties, processability 19
Krypton 85 finds another job—as static-eliminator 20
Oriented nylon strip developed for conveyor belting 20
Samples ready of new adhesive for bonding silicone rubbers 20

MECHANICAL:

Setscrew has special point; gives grip when tightened 73
Interlock for parts chutes in automatic handling systems 74
New drive mechanism promises greater thermodynamic efficiency 19
Surface fatigue is most common cause of gear failure 20

ELECTRICAL:

Continuous-reading meter-relay shows signal level at all times 73
Radomes for the DEW line—our cover story 5

HYDRAULIC-PNEUMATIC:

Solenoid air valve can be actuated by hand 73
Cartridge check-valve allows smaller-size circuits 73
Heat transfer to boundary layer flows reported in new book 125

PRODUCT DESIGNS:

Straightens odd shapes in less than 30 seconds 53
Latest model of famed camera uses steel-ball flexible linkage 52
Hydraulic multiplier checks load cells to eliminate errors 54

How B&W JOB-MATCHED EXTRUSIONS can reduce the cost of your finished product

. . . they meet your design and production requirements because the extrusion process can produce a variety of shapes in solid or tubular form

. . . they meet product end-use specifications because you have a choice of high-alloy and stainless steels, or special non-ferrous metals and alloys

. . . they save production time because operations can often be reduced to a mere cutting to length and a few simple finishing operations

Be sure it's B&W when you specify extrusions. Call your local B&W District Sales Specialist, or write for Bulletin TB-413 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-9004-E1

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

STANLEY J ALLING *publisher*

ELMER J TANGERMAN *editor*

ROBERT W CARSON *managing editor*
ROBERT E ABBOTT *senior associate editor*
RICHARD M KOFF *senior associate editor*

JOHN KOLB *associate editor*
NICHOLAS CHIRONIS *associate editor*
FORD R PARK *associate editor*
ROBERT S PRENTISS *associate editor*
ANNESTA R GARDNER *associate editor*
WILLIAM GILMAN *associate editor*
FRANKLIN D YEAPLE *associate editor*
JOSEPH J. KELLEHER *associate editor*
DOUGLAS C GREENWOOD *associate editor*

BENEDICT A LEERBURGER, JR *assistant editor*
PHYLISS A SWEED *assistant editor*
DORA K MERRIS *assistant editor*
HERBERT KEE *assistant editor*
CHARLES J LYNCH *assistant editor*
T M HAGGERTY *assistant editor*

FELIX GIORDANO *Detroit*
JACK MEYER *Los Angeles*
SETH PAYNE *Washington*

RICHARD E ROOMAN *art director*
E G LOADER *associate art director*
ANGELA M GIACIN *assistant*

NORMA J VAN NESS *production supervisor*
LILLIAN M WITHAM *assistant*

ROBERT E BRUCKNER *consulting editor*

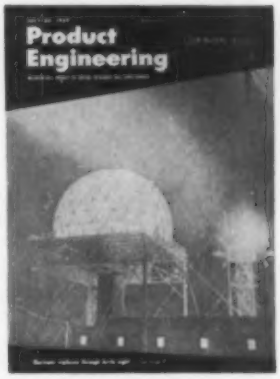
DEXTER KEEZER *director, economics dept*
GEORGE B BRYANT, JR *Washington*
DONALD MacDONALD *Detroit*
WILLIAM G MELDRUM *Cleveland*
STEWART W RAMSEY *Chicago*
MARGARET RALSTON *San Francisco*
JOHN KEARNEY *Los Angeles*
MICHAEL J MURPHY *Los Angeles*
RAY BLOOMBERG *Seattle*
CHARLES T DIXON, JR *Atlanta*
KEMP ANDERSON, JR *Dallas*

JOHN WILHELM *director, world news*
JOHN TUNSTALL *London*
JOHN SHINN *London*
ARTHUR ERIKSON *Paris*
GENE DI RAIMONDO *Milan*
RAYMOND SHAH *Zurich*
ROBERT GIBSON *Moscow*
ONNIC M MARASHIAN *Beirut*
PETER WEAVER *Mexico City*
JOHN PEARSON *Caracas*
SILKE BRUECKLER *Bonn*
JIM MORRISON *Bonn*
SOL SANDERS *Tokyo*
JOHN YAMAGUCHI *Tokyo*

PHILIP G WEATHERBY, *advertising sales manager*
P F PRITCHARD *manager, market research*
ROBERT C MATTOON *circulation manager*
C C KANE *reader and service manager*
RUSSELL T DOUGLAS *business manager*

Interesting to Note . . .

Eye to the Arctic Sky



Any military tactician will emphasize the importance of surprise when launching a military offensive. We were caught off guard at Pearl Harbor and maybe that tragic lesson has taught us not to be caught again. But adequate warning systems cost money and are never certain to do the job with 100% effectiveness. Today's bombers travel three times faster than World War II planes, missiles faster still, so time is a vital factor. Our cover shows the latest electronic watchdog, one of about 60 DEW line stations (Distant Early Warning) far above the Arctic Circle in Canada and Alaska.

There's nothing new about warning systems. Early warriors used birds and dogs to carry the message from observer to field headquarters. Exactly 371 years ago this week, the largest naval fleet of its day was turned back by an early warning system. The Spanish Armada—130 ships carrying 2500 guns and more than 30,000 men—sailed to conquer England. The British navy was prepared and needed only to know from which direction Spain would attack. On land, troops were ready should a beachhead be made. Still, a method had to be devised to quickly alert and summon these land forces to the right beaches. The ancient Persians used reflectors to send messages, so why couldn't the British? A heliograph would work only during the day, and that wasn't good enough; so why not bonfires? This was the answer. Wooden spires were built along the coast in a spoke-like network that had a central headquarters. When the Armada was sighted, the fires would signal their approach. It so happened, however, that the British navy defeated its foe in a fierce sea battle instead, and the impending invasion was thwarted.

The DEW line is our modern network of bonfires. Built by Western Electric, its radar finds the aircraft and relays their whereabouts to a central station, down in Colorado Springs, where the data are evaluated and a course of action determined. Where DEW is primarily for aircraft, a similar network, BMEWS (Ballistic Missile Early Warning System) is being built to do the job of spotting missiles.

The radome on our cover is a rigid structure 55 ft in diameter. Its 235 triangular panels are plastic. Previously, nylon cloth impregnated with Hypalon was used, but could not stand up against hurricane winds and subzero temperatures.

Two years ago Western Electric turned the completed DEW

(CONTINUED ON PAGE 7)

Product Engineering
A McGRAW-HILL PUBLICATION

July 20, 1959 Vol. 30, No. 29

PRODUCT ENGINEERING is published weekly, with an additional Design Digest Issue in Mid-September, by McGraw-Hill Publishing Company Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel right for directions regarding subscription or change of address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice-President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice-President; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders. Send to address shown in box at right.

United States subscription rate for individuals in the field of the publication, $5.00 per year, single copies fifty cents; Canadian subscription $7 per year; foreign $25 per year, payable in advance. Second-class postage paid at Albany, N. Y. U.S.A. ©Copyrighted, 1959, McGraw-Hill Publishing Company, Inc., all rights reserved.

UNCONDITIONAL GUARANTEE. IF PRODUCT ENGINEERING editorial service becomes unsatisfactory for any reason, paid-up subscribers may cancel their subscriptions on request to our New York office and the proportionate subscription price of any unmailed copies will be refunded.

PRODUCT ENGINEERING articles are indexed in both the **Applied Science** and **Technology Index** and the **Engineering Index**. PRODUCT ENGINEERING publishes its own semi-annual index. Copies are obtainable on request to the editor.

SUBSCRIPTION. Send subscription correspondence and change of address to Fulfilment Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Fulfilment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

Postmaster: Please send form 3579 to PRODUCT ENGINEERING, 330 W. 42nd St., New York 36.

The Heat's On

precisely . . . under the dependable control of Fenwal Standard Thermoswitch® Units

Key step in the manufacture of milk cartons on Pure-Pak carton-forming machines is the heat-sealing of the bottom flaps. For eight years this manufacturer has used Fenwal Series 17000 THERMOSWITCH units for temperature control of this vital operation. Result: eight years of precise troublefree control. *That's time-tested performance!*

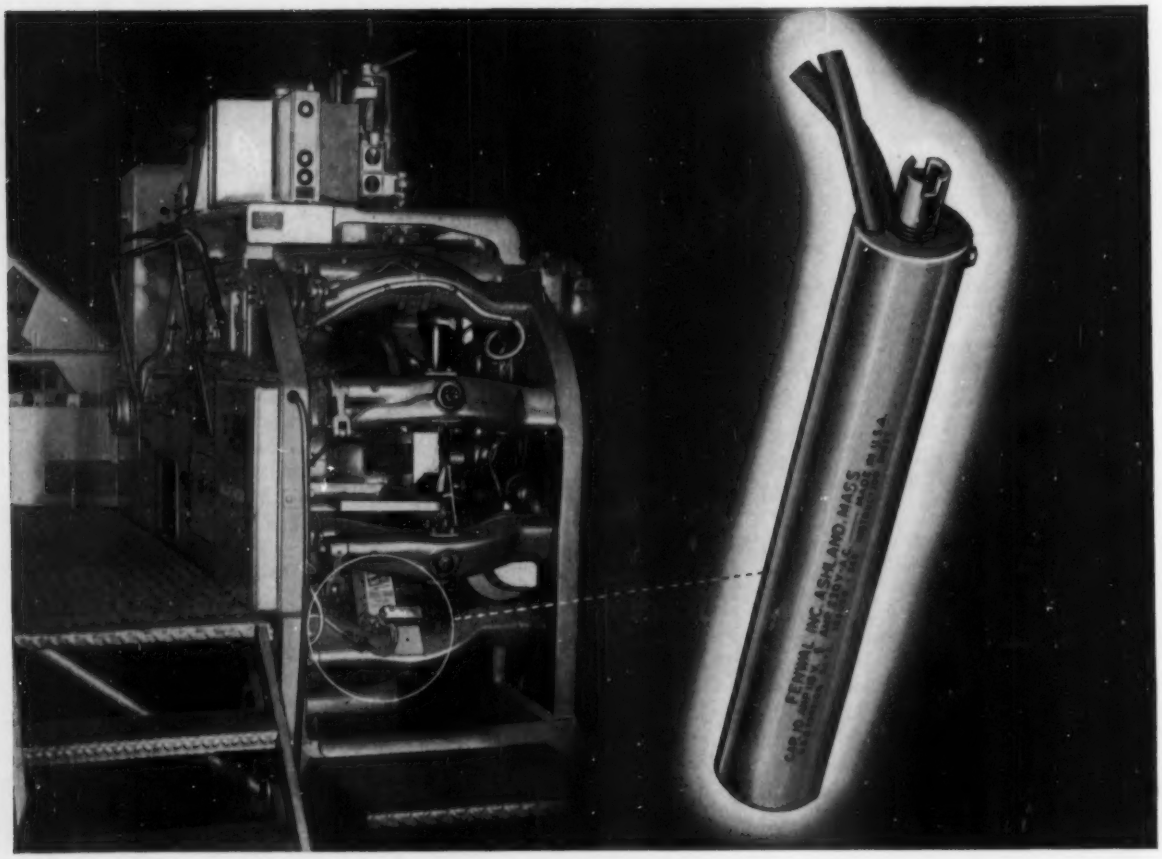
It's typical of the hundreds of successful installations of immersion and surface-mounted THERMOSWITCH units . . . in tanks, vats, air ducts . . . for widely varying space and position requirements . . . under the severest conditions of shock, vibration, and corrosion. *They're standard units with truly special capabilities!*

Yet for all their ruggedness, THERMOSWITCH units are sensitive to temperature changes of only a fraction of a degree. Heat sensitive outer shell responds instantly and accurately. *No thermal lag . . . no control error!*

Use these versatile units for control applications from −100 to +1100°F. They're completely adjustable with current ratings up to 10A-115VAC.

For complete details, write Fenwal Incorporated, 27 Pleasant Street, Ashland, Mass.

Compact, totally-enclosed Fenwal THERMOSWITCH units provide positive, service-free control of heat-sealing operation on this Pure-Pak carton-forming machine.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

line over to the Air Force, which in turn transferred operation to Federal Electric. It's now civilian-operated, employing about 700 people. Oddly enough, 75% of the radicians are young married fellows living away from their wives for one purpose—to earn money quick.

Salaries start at $850 a month; a sector superintendent can earn $17,000 a year. When a man completes his 18-month hitch he gets a $500 bonus; should he return for a second tour, he gets a substantial salary boost.

Take to the Links

Golf is one of the most popular pastimes of today's sportsmen. Whether just to consummate an important deal or only for plain relaxation, more and more people are taking to the links now than ever before. Not only is golf pleasurable for the participants, but most profitable for those engaged in the making and selling of the many golfing accessories. One new device for the golf-club industry is the shaft straightener described on p 53.

The game of golf was first played on the dunes of Scotland. These sandy, wind-scarred areas were and still are called "links." Around the 15th century, bent tree-branches were used as clubs and leather spheres stuffed with feathers were swatted around a rough course. Despite this crudity, Scot youths took to the game en masse. Their enthusiams prompted grave concern over what had been termed by members of Parliament "a security problem"—young reservists neglected their bows and arrows for the new game. An invasion was feared, so a law banning golf was passed; violators were to be imprisoned and fined. But golf was too popular and the decree was ignored. When King James IV became an enthusiast, the laws were relaxed and the game was played without qualms or fear of invasion.

The world's first woman golfer was of royal blood—Mary, Queen of Scots. Her lasting contribution to the game was the word "caddie." She used the term to summon an army cadet who carried her clubs.

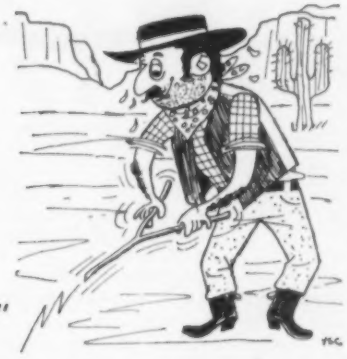
Sound Off

Several thousand years before Christ, a Greek priestess was regularly entranced by the volcanic rumblings she heard beneath the temple at Delphi. While in a trance, she shrieked and moaned, then began uttering meaningless sounds. Her gibberish was interpreted as coded predictions of things to come. Interpretations of this sort, based on sound effects, go back even further. Thunder, for example, was long thought to be a form of spiritual communication. Early Greeks even worshipped thunder, believing it to be the weapon of Zeus, ruler of the heavens.

The actual harnessing of sound probably can be credited to Joshua's horn blowing outside the walls of Jericho. A later military man, Alexander the Great, is said to have used a speaking horn which could assemble troops from eight miles around. Sound still is of special interest to military leaders today. An ultrasonic "sound fence" may some day actually prevent soldiers from crossing by emitting paralyzing vibrations; total absence of sound in space may lead perfectly normal men to insanity.

Although bats have emitted sounds with a frequency from 30,000 to 80,000 cps, ultrasonic waves (p 56) have only recently been adopted by industry. Now, thanks to ultrasonics we can analyze stresses, clean dishes, drill holes, emulsify liquids and even, if need be, destroy cellular tissue or kill small organisms.

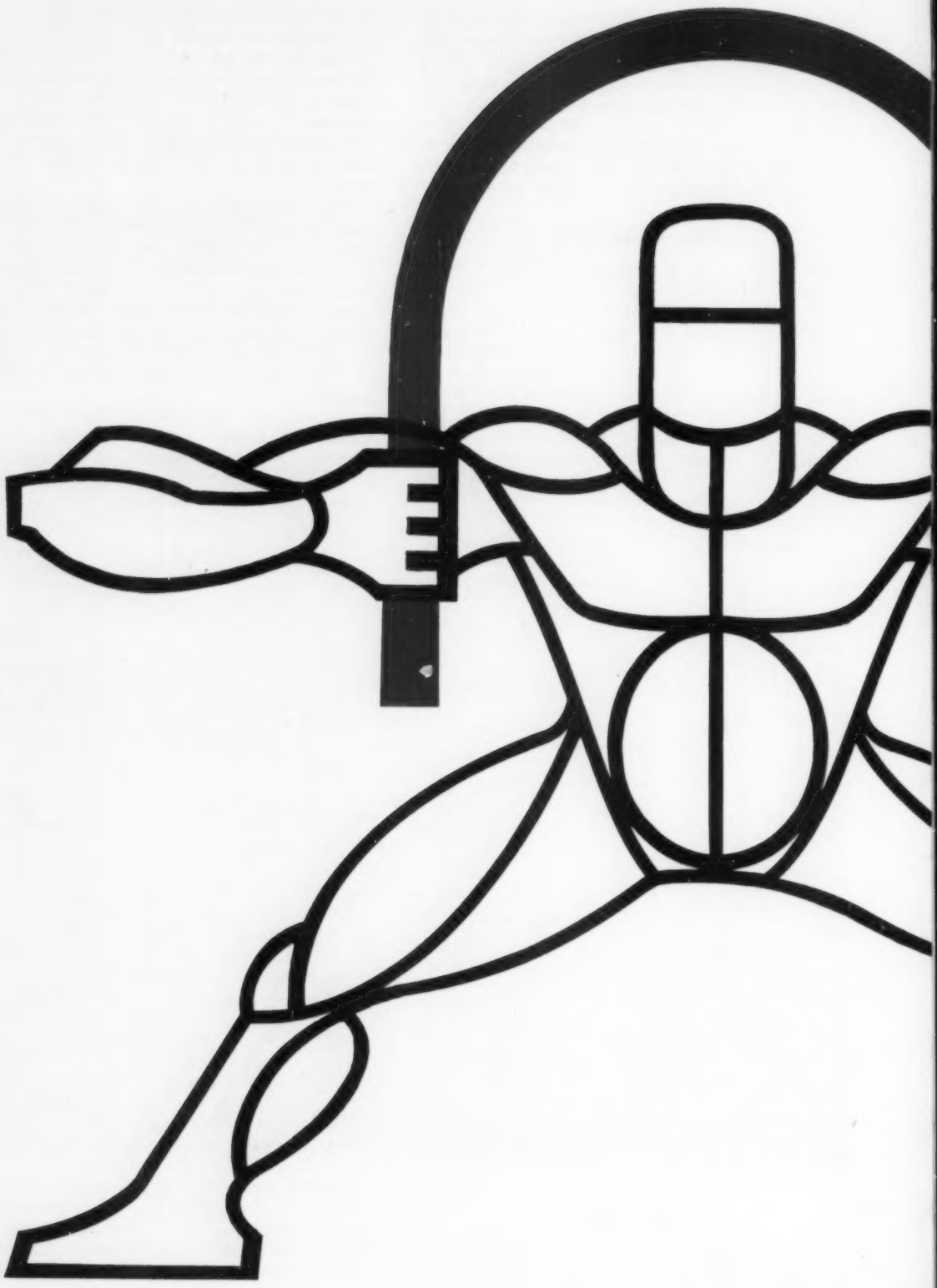
"Water, Water, Everywhere . . ."



"Water is where you find it." This version of an old adage has led diviners to spot underground wells with a forked apple or hazel wand, and in some cases even led an entire town's population to pack up and search for a more plentiful water supply. Once located, the next consideration has been developing a means of transporting the valuable liquid from wells or rivers to the home or field. Now pumps and pipes serve the purpose and engineers can calculate the exact pressures being fed through the pipes, regardless of complexity (p 60).

The development of the pump was one of our great technological advances. Previously, man himself served as the conveyor of liquid. In early times water was withdrawn from a creek by a leather bucket on a rope. Then, about 1500 BC, the pulley was developed and man's task was greatly simplified. Tragically, a great portion of the Indian and Arab world still relies upon this age-old method of drawing water. In some areas, a second man is lowered into the well or stream to assist the filling of buckets.

—Benedict A Leerburger Jr



NOW... SUPERIOR FORMABILITY IS AVAILABLE IN AN EXTRA-STRENGTH STEEL

N-A-XTRA

BEST LOW-ALLOY EXTRA-STRENGTH STEEL YOU CAN BUY

N-A-XTRA HIGH-STRENGTH is a heat-treated steel now available in minimum yield strengths of 80,000-110,000 psi.

Unlike most steels of this strength and toughness, N-A-XTRA can be cold formed into difficult shapes, gas-cut, sheared, machined, and otherwise handled by conventional fabricating methods. It has superb weldability—by any process. And its great strength gives designers and engineers a unique opportunity to eliminate useless dead weight from finished products.

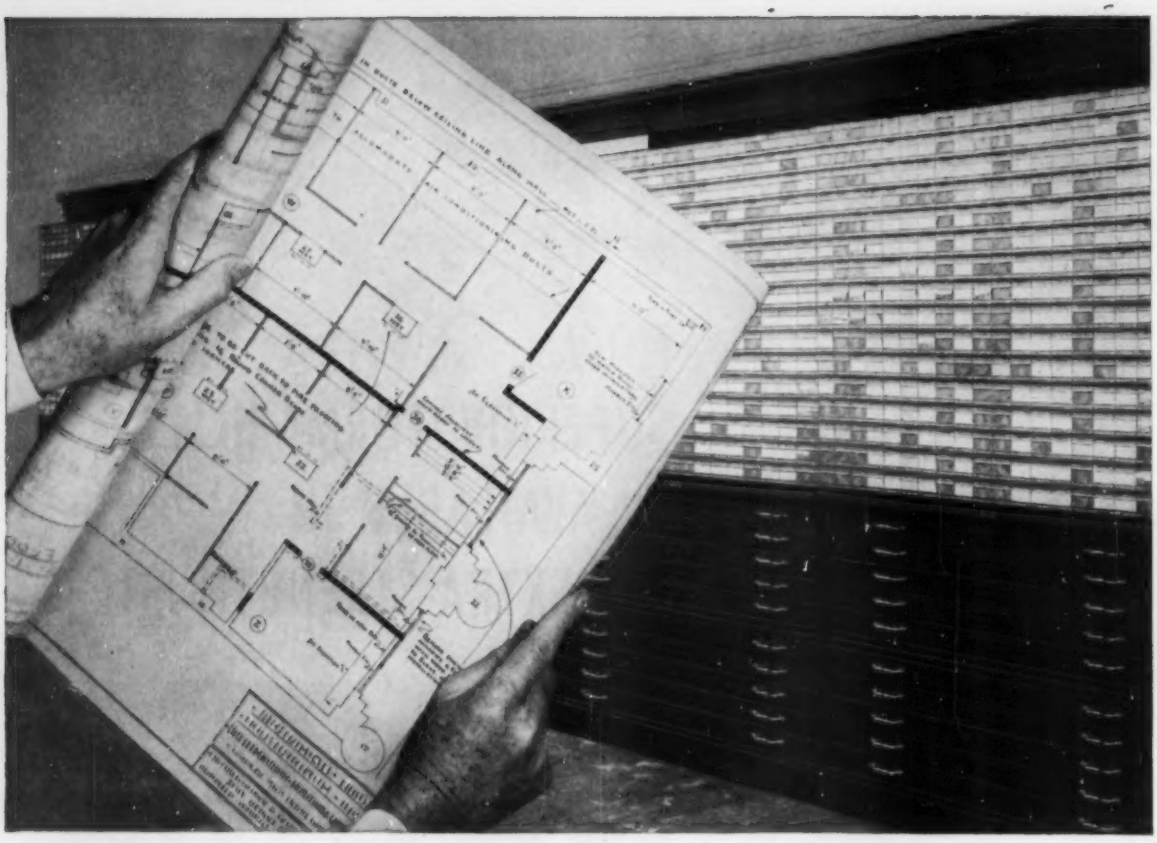
For complete information on N-A-XTRA—the best low-alloy extra high-strength steel you can buy—write Great Lakes Steel Corporation, Detroit 29, Michigan, Dept. C-9.

N-A-XTRA

GREAT LAKES STEEL

A DIVISION OF NATIONAL STEEL CORPORATION

CIRCLE NO. 9 READER SERVICE CARD



RESISTS DETERIORATION AND AGING!

Safeguard your investment in costly originals with durable drafting films of Du Pont MYLAR®

Your valuable original drawings resist slow deterioration, tearing and rough handling when you use drafting film made of Du Pont "Mylar"* polyester film. That's because the base—"Mylar"—is tough and durable . . . won't dry out or become embrittled with age. "Mylar" is flexible, stable . . . resists absorption of moisture.

Drafting film of "Mylar" provides good contrast for microfilming . . . makes paper intermediates unnecessary. Because it costs less than many grades of tracing cloth, drafting film of "Mylar" provides you with many new cost saving opportunities.

So next time you order, ask for pencil and ink drafting films of "Mylar". . . *safeguard your investment* in drafting time and labor.

If you would like samples for testing, we will ask manufacturers of drafting film of "Mylar" to send you a sample. Write E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room P-7, Wilmington 98, Delaware.

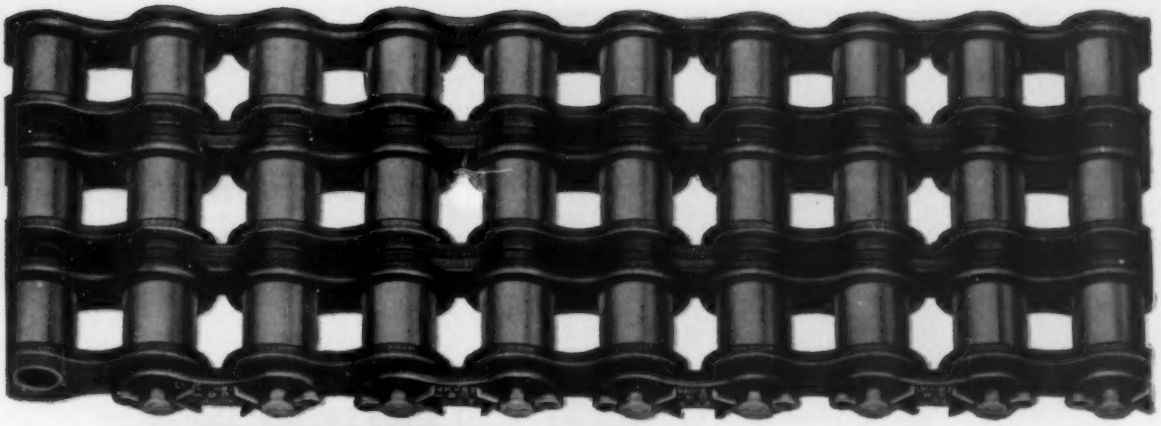
*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

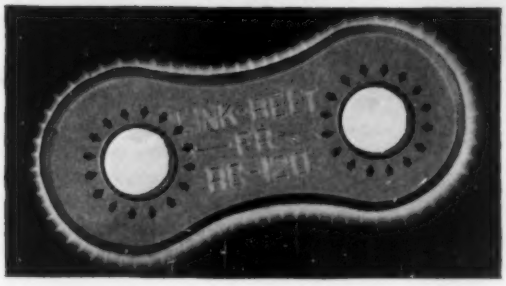
"Mylar" resists absorption of moisture and liquids due to accidental spillage.

"Mylar" provides extra protection against tearing . . . has good fold endurance.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

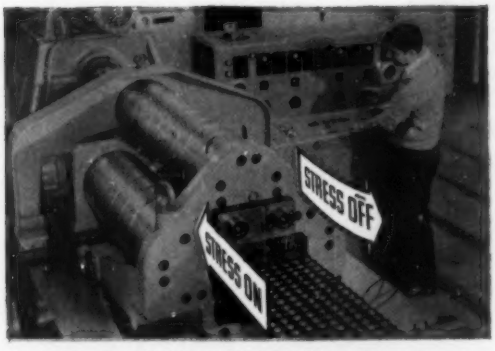
DU PONT **MYLAR**® POLYESTER FILM





Arrows indicate critical areas treated with compressive stresses to improve fatigue resistance.

Fortified against fatigue



65 TONS OF CYCLIC TENSION! With this equipment—largest of its kind known to be in operation in roller chain testing—Link-Belt tests and rates roller chains. Rapid "stress-on, stress-off" action duplicates operating conditions at a greatly accelerated pace . . . proving over and over that Link-Belt chains are fortified against fatigue.

Link-Belt offers special FR® processed roller chain for applications involving repeated high-tensile loads

Jobs too rugged for standard roller chains are taken in stride by Link-Belt FR roller chain. Through its patented FR process, Link-Belt gives *greater dynamic strength* to the larger sizes of chain most likely to encounter severe cyclic loading. FR greatly raises the chain's endurance limit by compressing metal around pitch holes—the critical sidebar areas most vulnerable to fatigue failure.

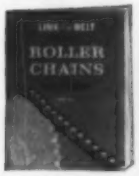
The FR process results from the same design and metallurgical research that has produced many more "extras", all *standard* in Link-Belt roller chains. They include shot-peened rollers, close heat-treat control, lock-type bushings and others. For further details on Link-Belt roller chains, send for Book 2657.

LINK-BELT

THE SYMBOL OF QUALITY — LINK-BELT

15,000

ROLLER CHAINS AND SPROCKETS



BOOK 2657 has 154 pages of roller chain data. For your copy, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.)

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

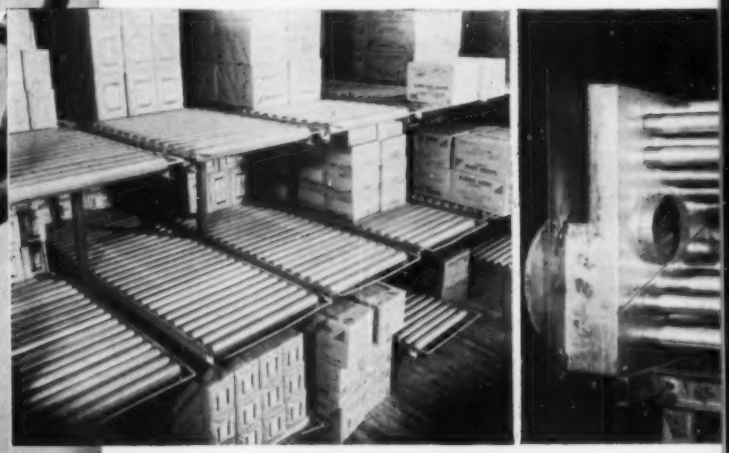
New steels are born at Armco

3 Ways to give plus strength

1. Armco ZINCGRIP Steel Tubing
2. Armco ALUMINIZED STEEL Tubing Type 1
3. Armco ALUMINIZED STEEL Tubing Type 2

These three grades of Armco's special coated steel tubing add low-cost protection against corrosion to all the design advantages of welded steel tubing. The reason: they are made of steel with mill-applied hot-dip coatings of zinc or aluminum. You can design tubular parts with built-in corrosion resistance that eliminates the necessity of painting, plating or other costly finishing operations.

Conveyor rolls are one of the many diversified applications where Armco ZINCGRIP Steel Tubing is giving excellent service. Many conveyor manufacturers have made ZINCGRIP Tubing their standard material because of its over-all economy and durability in both intermittent and continuous operations.



Armco ZINCGRIP Steel Tubing provides the strength and rigidity for gale-resistant microwave and TV towers hundreds of feet high. The adherent zinc coating doesn't flake or peel when cross braces are severely formed . . . assures over-all protection against rust.

your products low-cost durability and rigidity of steel tubing

For *your* products you can select the grade that meets your specific requirements with the best combination of cost and performance.

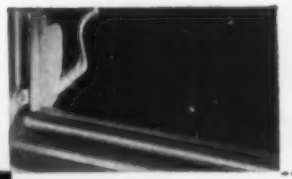
Armco ZINCGRIP® Steel Tubing—Welded steel tubing with a full-weight hot-dip zinc coating. It has many times the corrosion resistance of tubing with a light electro-galvanized coating. It can be severely formed in fabrication without flaking or peeling the special zinc coating. Available in rounds, squares, rectangles and special shapes.

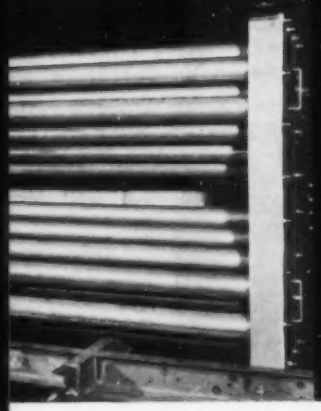
Armco ALUMINIZED STEEL Type 1 Tubing—A tightly adherent hot-dip aluminum coating provides resistance to a combination of heat and corrosion. The coating won't discolor when heated as high as 900 F and resists destructive scaling at temperatures up to about 1250 F. Available in rounds, squares, rectangles and special shapes.

Armco ALUMINIZED STEEL Type 2 Tubing—Welded steel tubing with a hot-dip aluminum coating that has especially good resistance to atmospheric corrosion. 18-year exposure tests in an industrial atmosphere show that the aluminum coating lasts at least twice as long as other protective coatings in its price class. Available in rounds only.

In the products *you* make or use, consider the design and production advantages offered by durable and economical Armco ZINCGRIP Steel or ALUMINIZED STEEL Tubing. For complete information on available sizes, shapes, properties and fabrication, just fill out and mail the coupon.

Torque tubes in jalousie and awning-type projected windows illustrate a practical application for Type 2 ALUMINIZED STEEL Tubing. Armco's aluminum-coated tubing provides rigidity, torsional strength, and low-cost resistance to weathering.





Heat exchanger tubes are an application for Armco ALUMINIZED STEEL Type 1 Tubing. Its resistance to a combination of heat and corrosion in this kind of exposure means longer and more satisfactory service at low cost. This extra-durable tubing is used in a variety of shapes for industrial, commercial and domestic gas heaters.

ARMCO STEEL CORPORATION
1889 Curtis Street, Middletown, Ohio

Send us additional information on:

- ☐ Armco ZINCGRIP Steel Tubing
- ☐ Armco ALUMINIZED STEEL Type 1 Tubing
- ☐ Armco ALUMINIZED STEEL Type 2 Tubing

We are considering it for the following applications_____

Name_____

Title_____

Street_____

City_____ Zone_____ State_____

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Technical data for gasket design and selection

Why close tolerances in resilient gaskets are rarely necessary

Tolerances in the size and shape of a gasket do not become critical if the gasket material chosen seals effectively over a wide compression range.

Armstrong cork-and-rubber compounds are typical of such wide range materials. They seal under compressions from 20% to 33%.

Because they are truly compressible, they decrease in volume under load, so tolerances in size may be as wide as .010", even in completely

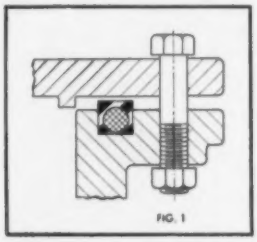


FIG. 1

confined space. In some applications, the wider tolerances allowed by compressible gaskets may effect savings in machining time.

The typical examples shown here illustrate how Armstrong cork-and-rubber materials help eliminate the need for close tolerances.

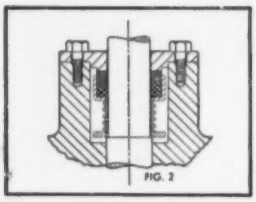


FIG. 2

Figure 1 shows relative sizes of a resilient cork-and-rubber gasket and a non-compressible molded ring of comparable size. The cork-and-rubber compound permits wide tolerance in its size, whereas the molded ring must meet very close tolerances to allow perfect fit between the flanges.

Similarly, in figure 2, wide tolerance cork-and-rubber gaskets make an effective packing ring. Their true compressibility controls lateral flow and prevents excessive build-up of radial pressure on the shaft.

Selecting gaskets for sealing internal pressures under stamped flanges

Effective sealing of stamped flanges is complicated by their normal surface irregularities and by a tendency for these light flanges to distort under low bolt pressure. Where these lightweight components must also seal internal pressure, the gasket problem usually will require special attention.

A pump manufacturer recently submitted such a problem to the Armstrong Research and Development Center. One flange of his pump was stamped sheet metal, with a nominal .125" thickness. A soft fiber gasket—approximately .090" thick—was used to seal water at 200° F. The pumps leaked under internal service pressure of 70 psi.

In the Deflectometer, fluid under pressure is pumped into the flange. The amount of deflection can be read from a micrometer which is held in fixed position relative to the flange surface. By moving the arm, readings can be taken at any point on the flange surface.

To find exactly how the internal pressure was causing leaks, research engineers used the Deflectometer, an Armstrong-developed laboratory tool. (See photo)

In the pump flange, under test, deflections of .007" at the center points between the bolts were found. (At flange center, the deflection was .040".)

The engineers then turned their attention to the gasket material, a relatively soft, compressible fiber sheet. Such a material requires fairly high bolt pressure to close its interstices, and such pressures were not available on the stamped flange. The deflection caused by the internal pressure was enough to open the gasket structure and permit leakage.

To find a gasket material that would provide an economical seal under the conditions imposed by the pump, the engineers tested various Armstrong materials. From among the several that sealed satisfactorily, they recommended Accopac N-840, a dense, beater-saturated fiber material.

N-840 offered several advantages. For example, none of the available bolt pressure was required to compress it to impermeability. And it could be used in 1/32" gauge—one-third the thickness of the original gasket.

More complete information on the effect of internal pressure and other factors of gasket design, selection, and performance is contained in the Armstrong Gasket Design Manual. Write for your copy to the address below.

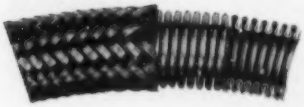
For your copy of the Armstrong Gasket Design Manual, write to Armstrong Cork Company, Industrial Division, 7007 Irvin Street, Lancaster, Pa.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

Whatever your problem in flexible hose connections,

call the Man from Anaconda Metal Hose



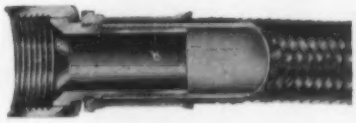
Seamless: Of tin bronze (98¾% copper, 1¼% tin)—also corrugated stainless steel—in sizes ⅛" through 4" I.D. For conveying fluids, chemicals, etc., under conditions of flexure or vibration and to allow for misalignment. Reusable (mechanical type), soldered or welded fittings.

Stripwound: Constructed from brass, bronze, aluminum, galvanized or stainless steel. Sizes ½" through 8" I.D. A rugged type of hose for general service as steam, oil, water, particularly where the hose is handled manually. Fittings: soldered or heat-proof (packed-on).

Type UI: Interlocked unpacked hose in galvanized steel, stainless steel, aluminum, etc. Sizes through 8" I.D. For ventilating ducts, dust collection, engine exhausts, exhausts at grinding machines, bottle chutes, drain lines, protective casing for flexible hose assemblies.

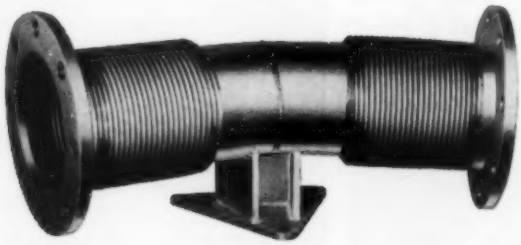
Diesel: Heavy-duty steel exhaust and air intake hose. Sizes 2" through 16" I.D. Designed for rugged, heavy-duty use. Helical corrugations with open or closed pitch. Also in stainless steel (type Y-21) for corrosive applications.

Flexpipe: Takes up travel in piping, connects misaligned ports, dampens noise and vibration in piping. Standard sizes and lengths. Available in bronze, stainless steel, steel; in sizes ¼" through 16" I.D. with NPT fittings, flanges or welding nipples.



Teflon* Anaconda flexible connectors of Teflon with stainless steel wire braid for use with pipe sizes from ⅛" through 1¼". Available in a wide variety of standard hose assemblies complete with fittings.

*Teflon is a DuPont trademark for its fluorocarbon resins.



AX Tubing: Large diameter tubing for big, tough jobs. Available in Type 321 Stainless Steel, and other metals and alloys. Sizes from 4½" through 14" I.D. Designed to handle axial and lateral movement—while conveying large volumes of liquids or gases—for bulkhead seals, etc.

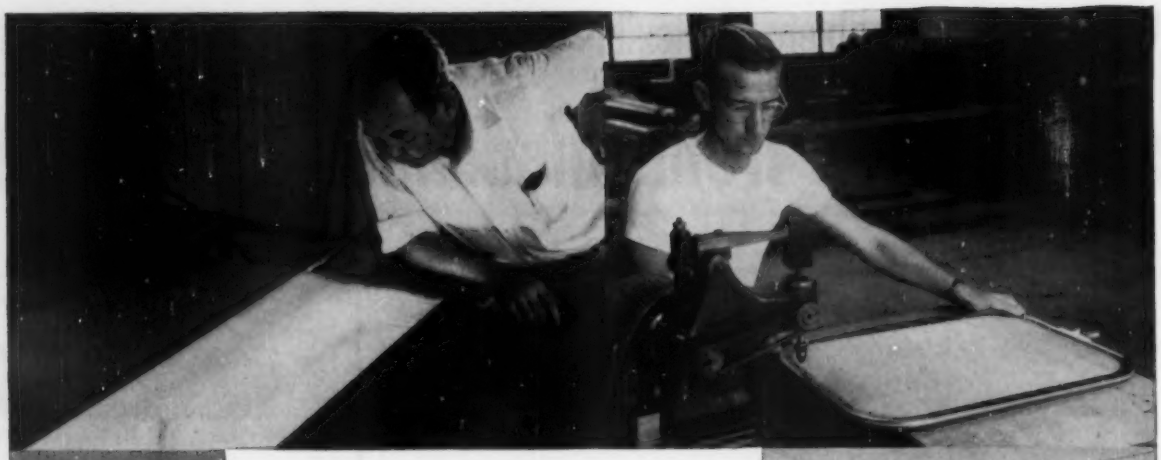
FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon, they can save you considerable time and money in designing the flexible connector best suited for any of your jobs.

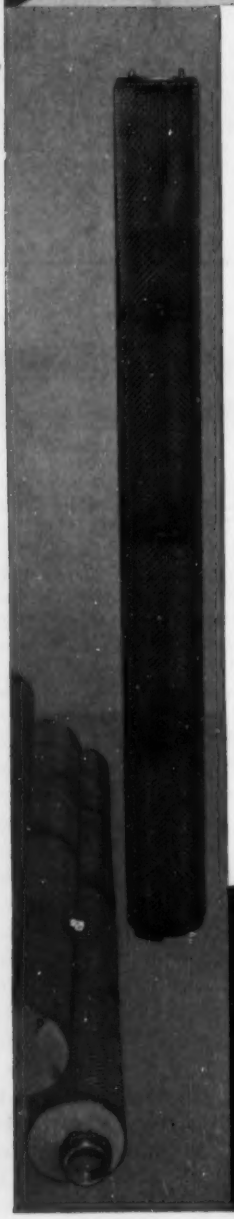
Our specialists are available to you through Anaconda Metal Hose representatives in leading cities—see listing "Metal Hose" in the Yellow Pages. Or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn.

50129

ANACONDA® METAL HOSE

CIRCLE NO. 15 READER SERVICE CARD





Who cares about your Wire Cloth Fabrications?

CAMBRIDGE does . . .

that's why you automatically get service with your order . . . whether you need dozens of midget strainers or a single giant-sized retaining screen.

Careful, competent workmanship and constant inspection assure you of quality . . . modern machinery and accurate scheduling assure you of prompt delivery. And, a Cambridge Field Engineer follows up your order to make sure our product is giving you the best possible service. Let us quote on your next order for wire cloth fabrications. We manufacture wire cloth from any metal or alloy—including titanium—in nine basic weaves. We'll work from your prints or draw up prints for your approval. Call your Cambridge Field Engineer . . . he's listed in the yellow pages under "Wire Cloth". Or, write for FREE 94-PAGE CATALOG.

The Cambridge Wire Cloth Co.

Department P • Cambridge 7, Md.

Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 64

NEW DESIGN TOOL FEATURED IN MOVIE

How designers use Silastic® RTV as a valuable tool is depicted in a fast-moving, 14 minute color-sound movie.

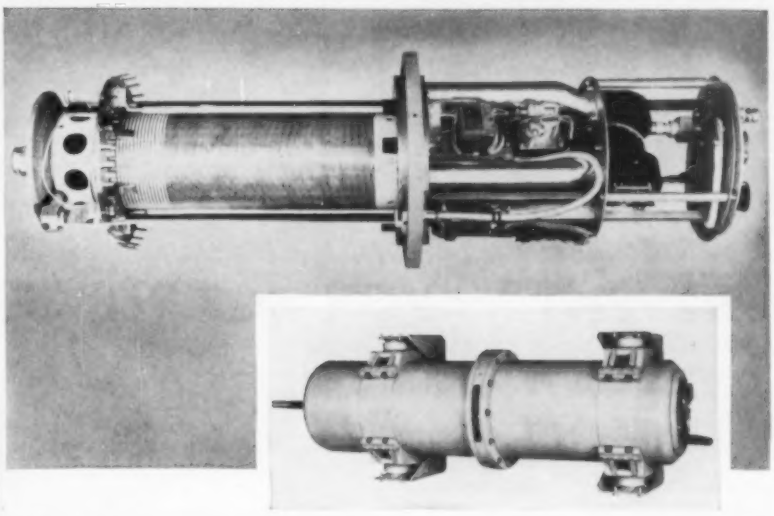
Design engineers in all fields put to practical advantage the unique properties of this silicone rubber that vulcanizes at room temperature.

For example, flexible molds with the finest of detail are easily produced. In turn, parts of low melting alloys and plastics, such as epoxy resins, are produced by simply pouring the molten material directly into

the mold. Temperatures up to 500 F do not affect the mold. Release is easy, quick.

One-of-a-kind rubber parts and prototype duplicates are also made easily and quickly of Silastic RTV. This unique product flows around even the most intricate shape, forms a custom built rubber part with minimum effort, and eliminates costly delays and the need for special molds.

In potting or encapsulating electronic units, Silastic RTV has proved to be an ideal medium. It provides the desired protection against shock, vibration, moisture and dirt. Because no heat is required to vulcanize the rubber, there is (Cont. pg. 2)



HOW TO HOLD DOWN HIGH FREQUENCY POWER LOSSES

When designing equipment for top performance and efficiency, losses must be held to the absolute minimum. That's why silicone-glass laminate was specified for coil forms in these antenna tuners designed for military radio transmitting sets.

Developed for the U. S. Navy by ITT Laboratories to provide high frequency band transmission of voice, facsimile and telegraph signals, this antenna tuner is one of the major building block components used in the installation of various models of radio transmitting equipments.

With a maximum power capacity of 500 watts, the antenna tuner is used in conjunction with such model transmitters as the AN/SRT-14. Another, the AN/SRT-15, may transmit an RF carrier of either a 100-watt or a 500-watt nominal level while the third, the AN/SRT-16, is capable of transmitting two carriers simultaneously.

Used in all three sets, the antenna tuner provides the means for resonating and matching the transmitter to its antenna. The RF (radio frequency) portion of the tuner consists of a main coil, a coupling coil and an electrically operated RF switch.

Wound on a 5.62 inch diameter cylinder of silicone bonded glass laminate, the .064″ diameter silver wire of the main coil spans 16″ of the coil form's length.

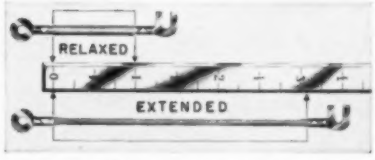
Glass cloth bonded with Dow Corning silicone resin was chosen for the main coil form after comprehensive tests confirmed this material would assure low losses at high frequency operating levels.

Strong and lightweight, silicone bonded glass laminates maintain optimum dielectric properties and high mechanical strength even at temperatures of 250 C. They also provide low water absorption plus superior resistance to arcing, corona, and corrosive atmosphere. **No. 652**

NEW S-T-R-E-T-C-H WIRE

A new type of wire offers extended utility — because it's stretchable. Manufactured by Stretch Wire Corporation, New Rochelle, New York, the wire is available insulated with Silastic®, the Dow Corning silicone rubber, for superior performance under extremely adverse operating conditions.

Designed for use on requirements of 50 watts or less in appliances, portable tools, communication systems, aircraft and missiles, as well as special military underwater applications, Stretch Wire has an extension factor of 165% or more and return.

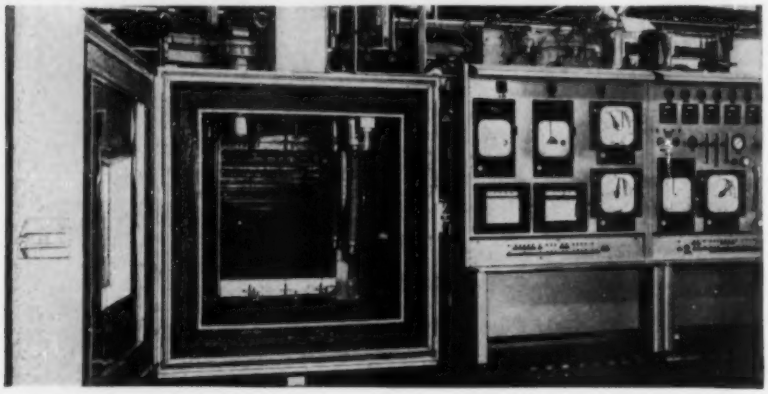


In missile and ordnance work, Stretch Wire has been proved to work effectively at high velocity launchings at speeds of 1000 feet per second and to withstand inertia loads of 800 G's.

Stretch Wire engineers chose Silastic because of its highly desirable (Cont. pg. 2)

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE



PREVENT VAPOR BLOWOUTS

Fluids in closed systems subjected to temperature extremes can cause problems—require special designs to withstand vaporization pressures. How best to cope with this high pressure hazard? Eliminate it by using a silicone fluid—according to Tenney Engineering, Inc., Union, New Jersey.

Tenney builds environmental test chambers used in testing electronic gear and guidance packages for aircraft and missiles. These chambers are required to produce test temperature conditions that range from as low as —170 F to a high of 1200 F.

These high and low temperature service requirements created serious problems. Most heat transfer fluids evaluated were not practical for temperatures as low as —90 F. Those that were suitable at low temperatures developed high vapor pressures at elevated temperatures. This meant designing the unit to withstand high pressures . . . eliminate chances of blowouts and possible fire hazards.

Tenney engineers, however, made their test chambers far safer and virtually trouble-free by selecting 2 centistoke Dow Corning 200 Fluid as the heat transfer medium. This nonoxidizing, nongumming and noncorrosive silicone fluid builds up only negligible vapor pressure. Over the chamber's operating temperature span, vapor pressures of this silicone fluid never exceed 50 psi, virtually eliminating the possibility of leakage. No organic fluid compares in performance.

Besides eliminating a fire hazard, Tenney engineers were able to keep the design simple by using 200 Fluid. In addition, the silicone fluid makes possible the use of one control system for both high and low temperature testing. *No. 653*

STRETCH WIRE *(Continued)*

combination of properties. Its brittle point is lower than —150 F and still it is serviceable at 500 F and higher. Silastic is highly resistant to heat, oxidation and chemical attack, and its water absorption is low. Electric strength remains constant over a wide operating temperature range.

The desirable combination of properties of Silastic that help make Stretch Wire practical for a wide variety of applications makes it valuable in solving other diverse design problems. *No. 654*

SILASTIC RTV *(Continued)*

no adverse effect on delicate, sensitive components.

Calking and sealing where extreme temperatures are encountered is still another area where Silastic RTV has proved to be very practical. It conforms to the required shape, stays flexible and serviceable from —70 to 500 F.

To make arrangements for a free showing in your plant of this movie about a product with uses limited only by one's imagination, circle . . . . . *No. 655*

new literature and technical data on silicones

When you consider all the properties of a silicone rubber, you'll specify Silastic. When fuel, oil, solvent and chemical resistance are special requirements, you'll want to refer to a new data sheet that describes the effect of various acids, bases, solvents and oils on Silastic. This valuable designer's reference will aid in selecting the best type of silicone rubber to meet your requirements. *No. 656*

Do you know that Class H insulated transformers offer smaller size and lighter weight, plus better performance and lower maintenance costs? A recent article cites the role silicone insulation plays in making such savings possible. *No. 657*

You say, they save — You can provide up to 100% longer surface protection if you specify silicone-based paints for the domestic appliances and the industrial equipment you design. Examples of design-customer savings are illustrated in a new, 4-page brochure. A unique, full page graph will help you choose the type of paint best suited for every application, and a separate listing of producers of silicone paints is also included to assist you in obtaining the protective coating you seek. *No. 658*

The big picture—A cross-section of silicone products and their diversified applications is compiled in the illustrated Reference Guide to Dow Corning Silicones. Over 200 products, for domestic and industrial applications, can be reviewed at a glance. Brief but descriptive explanations offer the information you'll want to use in considering Dow Corning Silicones to help solve your design problems. *No. 659*

Electronics exposed — A new silicone dielectric readily flows around electronic parts and subassemblies, then gels to a transparent, protective cushion. Its use avoids stress difficulties common to rigid potting materials, eliminates problems of sealing liquid dielectrics, allows visual inspection, and even permits test probing because it reseals itself. *No. 660*

Dow Corning Corporation, Dept. 8619, Midland, Michigan

Please send me: 652 653 654 655 656 657 658 659 660

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

DEVELOPMENTS TO WATCH...

New polyethylene rubber, improved both in properties . . .

. . . and processability, is now being tested by molders, will soon be available in molded and extruded goods—for wire coating, belting, packings, gaskets, and a variety of special parts.

Biggest advantage of the new material, to be known as Hypalon 40, is its processability; but Du Pont says it also offers improved tensile and tear strength, abrasion resistance, elongation characteristics, and compression set. Flame and oil resistance have also been improved, to the point where they are now comparable to neoprene, without sacrificing the material's natural chemical resistance, ozone resistance, and weatherability. DuPont expects it to replace the currently available Hypalon 20 in a good many applications, and to find a number of new jobs as well.

Oxygen increases the lubricating ability . . .

. . . of sulfurized white oils at elevated temperatures and improves their load-carrying ability at room temperature, says Douglas Godfrey of California Research.

In these mineral oils, dissolved oxygen seems essential for efficient performance of the iron sulfide films which actually serve as the friction-reducing medium. These oils do not perform as well in argon as they do in air. One indication: use of extreme-pressure lubricants of this type for high-altitude and space flight may present new problems.

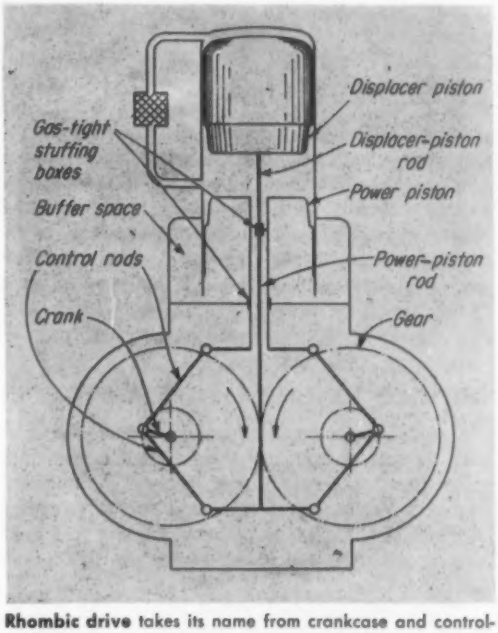
Surprisingly, addition of water to the oil also helps to reduce the coefficient of friction, particularly above 230 F; and a combination of water, white oil and oxygen shows a coefficient of friction for steel-on-steel at 500 F at least 40% lower than that for white oil alone.

For highly refined spindle oils, though, these rules do not seem to hold true. Japanese researchers, in a paper prepared for the World Petroleum Congress (*PE—June 1, p 9 and 11*) said: The coefficient of friction of steel-on-steel surfaces lubricated by highly refined spindle oil (with or without small amounts of palmitic acid or cetyl alcohol) is "very much smaller" when measured in vacuum than when measured in air.

New drive mechanism that promises greater thermodynamic efficiency . . .

. . . for hot-gas (Stirling cycle) engines has been developed by Philips of Eindhoven (Netherlands). Essentially, it's a multiple four-bar linkage system that makes it possible to separate power and gas-transfer mechanisms and eliminate the need for pressurizing the crankcase. With previous systems, in which power and gas-transfer functions were combined, the crankcase had to be pressurized to limit leakage of gas past the piston and to limit downward forces on the drive mechanism.

In the new system, called a rhombic drive (see diagram) there are twin cranks and control-rod mechanisms, identical in design and offset from the central axis of the engine. The cranks rotate in opposite directions and are coupled by twin gear wheels. Says R J Meijer of Philips: "The symmetry of the system and the coaxial arrangement of power-piston and displacer-piston rods make it an easy matter to avoid putting the crankcase under high pressure . . . The power-piston rod stuffing-box is subject to no lateral thrust, and the friction forces are low." Only the buffer space need be filled with gas under pressure; and this, he says, is much more easily done than pressurizing the whole crankcase.



Rhombic drive takes its name from crankcase and control-rod arrangement. Note that power-piston rod is hollow and displacer-piston rod runs through it.

DEVELOPMENTS TO WATCH...

Oriented nylon strip for conveyor belting . . .

. . . has been developed by E D Geoffrey Grath & Associates, 382 Springfield Ave, Summit, NJ. This is high-strength material said to have good resistance to elongation; and the company says it can be marketed for less than $2/lb.

Also new from Garth: a clear nylon film with a tear strength of 60 gm/mil (Elmendorf), and a tensile strength of 11,000 psi. Continuous operating range is minus 100 to plus 150 F, with intermittent use at temperatures to 380 F.

Note: for more news of nylon, see *PE*—June 29, p 13.

Key to fatigue failure of metals at elevated temperatures . . .

. . . is surface grain structure, say Naval Research Lab metallurgists.

The first clue came from an investigation of the high-temperature creep-rupture behavior of nickel in air and in vacuum, where, it was found, "the presence of a fine-grained surface layer increased rupture life and reduced minimum creep rate."

Now, NRL researchers have extended their study to Type 316 stainless. Sheet metal specimens, electropolished (to remove the layer cold-worked by machining) on one side only, were cycled from room temperature to 1500 F. Though electropolishing not only removes the cold-worked metal, but also tends to round off corners and reduce stress concentrations, all specimens failed on the electropolished face, in both air and vacuum. The reason: At the upper temperature, the cold-worked layer on the unpolished face recrystallizes to form a surface layer of fine grains; and this, say the NRL researchers, "is of prime importance."

To bond silicone rubbers that vulcanize at room temperature . . .

. . . Hughson Chemical Co, Erie, Penna, is readying a new adhesive which, it says, performs well at both high and low temperatures, shows good strength, and will adhere to aluminum, brass, glass, ceramics, and most thermoplastics. It cures as the rubber vulcanizes, to form a bond "stronger than the elastomer itself." Hughson also foresees its application as a potting compound.

It's not yet in full production, but samples are available for evaluation from the company (a subsidiary of Lord Manufacturing). Address Dept 88 A. Adhesive number is EX-B579-1.

Safer, more effective static eliminators . . .

. . . for printing and textile machinery, communications equipment, and other applications are promised by research now in progress under AEC sponsorship. Major effort will be towards development of devices that substitute the relatively safe and inexpensive radioactive gas, krypton 85, for more-dangerous isotopes previously used. Krypton 85 is a "soft" (beta) emitter, rather easily screened; and, being a gas, it rapidly disperses in air if its container is broken, leaving no dangerous residue.

Because krypton 85 is also being used in nuclear batteries (*PE*—May 12 '58, p 72) and has potential applications in gaging and signaling devices, AEC is also sponsoring basic research on this isotope. Air Reduction, for instance, is investigating krypton's behavior and developing techniques for handling it.

Surface fatigue is the most common cause of gear failure . . .

. . . says G E Huffaker, Chrysler Corp supervisor of gear design. Scoring and bending fatigue, once major troublemakers can now be largely eliminated by such measures as full fillet radii and shot peening of the fillet root. But compressive loading that leads to surface fatigue and failure of gear teeth is a continuing problem. Says Huffaker:

"Very little information on compressive loading and gear life is available." However, surface-fatigue failure in gears seems similar in many respects to surface-fatigue failure in bearings, and progress in this area indicates it should be possible to solve gear-failure problems as well.

Huffaker's group has developed a dynamometer test and a gear-failure curve which takes account of pressure angle and helix angle as well as face width; and is now making additional tests "to establish speed or dynamic loading factors which will increase the flexibility of the present curve for design use."

—ARG

What's New in Soviet Engineering and Design

The Soviet Exhibition of Science, Technology and Culture opened at the NY Coliseum this month. Last week, we reported on the appearance of consumer and industrial goods (PE—Jul 13, p 34). This week we evaluate some design features of USSR equipment.

In General

This exhibition is *not* vital for what it can teach American specialists. It *is* vital because it brings to Americans in general their first personal view of Soviet culture and technology in two decades. And it will impress the daylights out of a great many Americans who don't know the state of our own technology or culture. Further, it illustrates pointedly to Americans who have visited the USSR how rapidly that economy is developing—the acceleration in technology I've talked about. There are products here that did not exist a year ago (*PE—July* 14 '58), most of them part of a fast-paced plan. And increasing numbers of the new products are in the civilian and luxury classes. TV designs are new and bigger, so are cars—and show American styling. There is variety in wrist watches, in clothes, in fancy foodstuffs; there are stereo record players, furs, silks, high-style shoes, art objects.

There is also a 3-room model apartment, shown at Brussels last year, and a number of exhibits to show what is available in personal products. There are tremendous displays on education, on rehabilitation of war-damaged and time-damaged historical monuments, on music, the theatre, movies, art and folk art. They all help to round out the picture of Ivan and his interests. I have found in the past year of speech-making that Americans, lay and engineer, are really much more concerned about the Soviet people than they are about either the economy or the technology. Well, here is a show of what the Russians can buy and some of what they do, and at least 150 real live Soviet citizens to observe and talk with. Obviously many of the things shown are beyond the means of the average Russian, but then I suspect that some of the American products displayed in Moscow are probably beyond your means and mine. An exhibition in a foreign land must brag a little.

The key point for engineers here is that industrial development is not lagging as a result of the increase in luxury items. The tremendous acceleration that has marked Soviet industrial development persists. Tape controls for the two millers are far simpler and better than those shown last year at Brussels, the loading devices on other machine tools are as fast and as positive as our own, the electrical-discharge machine is heavier-duty (23 kw) and appropriately faster than what we've seen here. There is a model of a tunnel-digger for subways—a mechanized unit announced recently.

We might mention other examples, but we've taken another tack instead. We've followed the very-successful method of reporting we have used at the last two Design Shows—a number of specialist engineer-editors each appraising the exhibits in his own field. None of them has previously seen Russian industrial development in the flesh, so their reactions are probably what yours would be. They may help you pick your own course through the paradox that has always been Russia, which in our day is complicated by the conflicting reports available on every hand. As in the old-fashioned phrase about handkerchiefs, you must pick for yourself "what is for show and what is for blow."

—E J Tangerman

Specifically

If the Russians have it, they haven't got it here—a scientific or technological breakthrough, that is. The Soviets are proudly exhibiting their sputniks, their thermonuclear machines (*PE—July* 13, p 13), and their scientific instruments. But they aren't telling us much they haven't told before. Many of the exhibits, for instance, are unchanged from Geneva (Sep 1958) and Brussels (summer 1958). As a matter of fact, the whole exhibit seems planned to show that the Soviets are up to us—but not ahead. What bragging they do, aside from sputniks, is on an historical rather than futuristic basis. They make much, for instance, of a space ship, claimed to have been designed in 1903 by "the outstanding Russian scientist, Tsiolkovski, who is the founder of the scientific theory of space travel."

The anxiety of the Russians to show that they do have everything we have sometimes has amusing results. Our own Thiokol Corp, producer of polysulfide synthetic rubber, would find, for instance, that a Russian booklet on elastomers produced in that country not only lists silicones and fluorocarbons but also *thiockols*.

In the atomic energy area—one of the largest sections—the Russians again pursue the "separate but equal" policy. They show models—of almost every major type of fission reactor—sodium-graphite, uranium-graphite, boiling water, fast breeder, and so on. The models are beautiful. They are, however, considerably less detailed

than ours. Steps in a process, however, are traceable if time is taken.

For reasons best known to themselves, the Soviets devote a great deal of space and attention to test instruments, showing everything from electron and luminescence miscoscopes to non-contacting optical micrometers and interferometers for checking the deviations of ball surfaces. They have vertical length-measuring devices, leadscrew measuring devices, and gear-tooth checkers. These are different in design from ours—but not markedly.

In scientific photography, incidentally, the Russians seem to be making a good deal of progress. Not only do they show a camera with a drum-type magazine that is said to take up to 100,000 frames a second; but also one for thermonuclear research said to be capable of recording at the rate of 33,000,000 frames a second. This is an optical device that "takes advantage of the ability of a flat mirror to double the turning angle of a ray."

In one case at least, an apparent Russian claim is simply a matter of a difference in terminology. They claim a 1,200,000-kw *thermoelectric power station*. Our largest: 100 watts. But, to us, a "thermoelectric generator" is one for direct conversion of heat to electricity, via a thermopile or semiconductor (*PE—May 4, p 32*). To them, it is simply the use of heat to make electricity. Examination of the model shows it to be a completely conventional coal-fired station.

In some respects, there are surprising gaps in the exhibit. Their display of plastics is, to say the least, minimal —and puts their worst foot forward. Their transistors, too, are simple, and only conventional types are shown. There is no hint of work with such advanced materials as silicon carbide and the intermetallic compounds.

There is evidence throughout the show that the Russians have borrowed extensively from us. But they have not hesitated to dip into the technology of other countries as well. Several of the machine tools, for instance, show definite Swiss influence and the cameras have a German flavor.

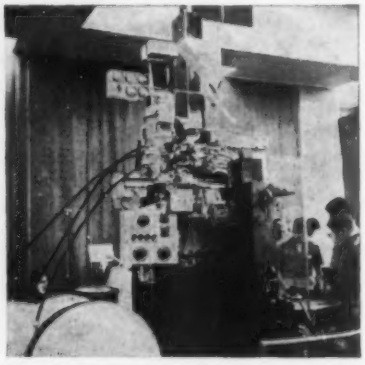
Over-all verdict on the show: well worth seeing; plenty of give-aways in the form of literature; but few concrete design ideas to take away.

—Annesta R Gardner

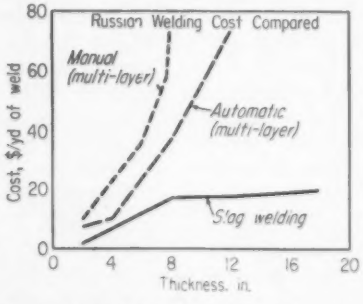
Materials and Production

Designers choice of material appears limited to steel

'Slag' welding . . .
machines, designed to weld heavy sections like press frames and turbine rotors, are being adapted for thicknesses over 20 in. Essentially a consumable electrode casting technique (*PE—Jan 19, p 64*), 'slag' welding achieves the greater thicknesses by substituting flat strip for conventional wire electrodes.



For either technique, consummable electrode feeds off coils (lower left in photo above) through multiple guides into weld puddle between two upright pieces being joined. Strip (or 'plate' in the Soviet lexicon) electrodes permit much higher rates of metal feed, thus allowing thicknesses above 20 in. to be welded at close to the lineal rates achieved with wire electrodes: approximately 0.5 yd/hr vs 1.0 yd/hr with wire. Cost of 'slag' welding is low compared to multiple-pass manual and automatic welding. Shown below are comparative costs provided by the Soviets at the Exhibition. Precise



basis of cost figuring is not known. In this chart, metric measure has been converted to English, and tourist exchange rate of 10 rubles/dollar was used (instead of the official 4:1 rate) as a realistic comparison base.

Submerged arc welding in this country costs about $9.30 per yd (operator's time plus metal cost) for 2 in. thickness. This compares well with the $7.30 per yd figure shown for Soviet 'automatic' welding. Adjusting the ruble-dollar ratio to 8:1 (a more realistic figure, according to some experts), brings the Soviet figure to $9.15 per yd. Such a cost comparison is risky, but would seem to indicate comparable welding technology and operator competence in the Soviet Union and the United States.

Spark-coating . . .
is a reverse twist on spark-machining, (*PE—Mar 2, p 59*) and the Soviets are using it to advantage as shown by this Type UPR-3M hand gun and spark generator. As operated here by Alexander Nikonov of Moscow's Electrometallurgical Laboratory, the 1.2 kva machine controls the spark impulse interval so that the gun tip vaporizes and deposits on the cathodic

workpiece. This is the reverse of spark machining, where the workpiece is the anode and energy impulses are controlled so that re-deposition does not occur. Wear-resistant coatings for surfaces of parts like cam shafts, sewing machine dogs, and gear teeth can be laid down using many metals and alloys—including W, Mo, FeC_2, Be, Cr, Al, and cobalt-base combinations.

Plastics . . .
as engineering materials are not yet a big factor in Soviet product design, judging from close scrutiny of consumer goods and industrial equipment. Basic reason is that Soviet plastics industry is just now getting up momentum and main emphasis is on R & D

(*PE*—Feb 9 '59, p 23). Glass-reinforced plastics were conspicuously absent in many of the places we find them in US products—instrument and machine tool housings, autos, furniture, transport cases and the like. One sample of packing material of silicone rubber reinforced with glass cloth was noted, along with an unusual fabric—glass cloth with strands coated with fluorocarbon resin—for which no use was given. Some phenolics were in evidence in electrical applications, and nylon door latches and vinyl seat coverings on the European model are specified on Soviet auto, along with some plastic dash components (*PE*—July 6, p 35). —Ford Park

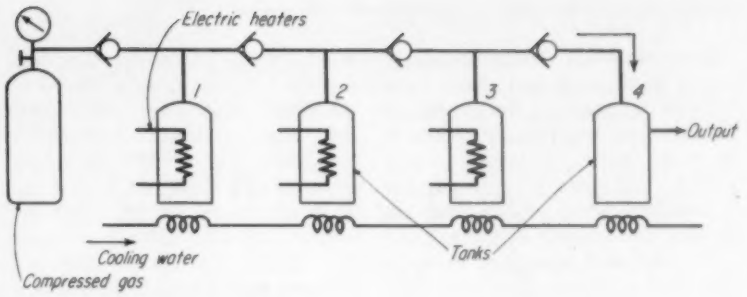
Costly construction methods . . .
seem to tell a significant tale about Russian products on display. Heavy-coal-mining equipment, agricultural machinery, an electro-slag welder, and general-purpose test equipment for fatigue and tensile strength tests all show a surprising lack of cast-metal parts. Some of these parts even seem to bear evidence of attempts to simulate castings by smooth-finishing and thick painting over the fillet welds. Simple brackets are also machined out of solid metal in cases where the process would be ridiculously expensive for quantity production when compared to forging or casting.

Why are such parts so made? An obvious conclusion is that the equipment on display is either prototype or is not being made in large enough quantities to justify tooling costs for castings. Perhaps there are other reasons. This question was put to a Russian guide, but he said he was an electrical engineer and did not know the answer. —Doug Greenwood

Motors and Controls

Profusion of nameplates but no graphic symbols on controls

Stepping motors . . .
give quick, non-hunting response in a new two-dimensional tape-controlled vertical milling machine, Model 6N13PR-2, made in the USSR. The driving power, however, is through hydraulic amplifiers that keep in step with the 20-watt motors. The control is open-loop, capable of up to 400 cps pulses to the stepping motors, each pulse rotating a motor about 3°. Ball-bearing lead screws assure smoothness. Over-all machinery accuracy, limited by step-movement, is about 0.002 in.

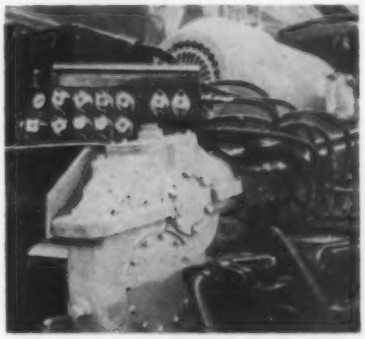


A pistonless compressor . . .
with claimed output pressure of 16,000 atmospheres at maximum flow of 250 cc's/hr is being demonstrated. The compressor, designed as a tool for growing crystals under high pressures, was designed and built at the Institute of Crystallography, Academy of Sciences. The working model shown had 14 stages (this sketch only shows four) and for safety and other reasons was operated at pressures less than 3000 atmospheres. No circuit diagrams were available, but in principle the compressor works like this: (A) bottle of compressed gas discharges through the check valves, filling all tanks with moderately high pressure gas; (B) tank number 1 is heated with a high-amperage electric coil; (C) pressure from tank 1 increases and escapes to tanks 2, 3 and 4 through check valves; (D) cooling water, fed continuously around all tanks, cools tanks 2, 3 and 4 as they are filling so that the high pressure will remain; (E) heater is turned on in tank 2, and process is repeated to raise pressures in tanks 3 and 4; (F) heater in tank 1 is turned off, tank 1 cools, and pressure drops; and (G) compressed gas bottle recharges tank 1 in readiness for next cycle.

Stacked-diaphragm . . .
pneumatic controllers for automatic processes are also exhibited. One has 14 layers, 12 external adjustments (3 with built-in micrometers), and 4 ports. It is made of steel, and is extremely heavy compared with those of American design. For electrical automation, a relay test panel is being shown. It is essentially a low-resistance telephone-type patch-board enabling relay circuits to be quickly tested.

Printed circuits . . .
were highlighted in a few exhibits—a radio transmitter, one or two radios, and some TV sets. But by far the greatest production is apparently with conventional wiring and electron tubes. Transistors were also highlighted, but production quantities in industrial or consumer products were not in evidence. Some parts of a few computers have them. More in evidence are germanium diodes, found in a large variety of radios and TV sets. Several Soviet engineers commented on fact that transition from tubes to transistors is quite likely in many areas, because in Russia the cost of making tubes isn't much less than the cost of making transistors.

Coal cutter-loader . . .
a typical assembled product, emphasizes some interesting differences—as well as similarities—between Soviet and US design. The cutter-loader is an electric-powered coal-mining machine that makes a tunnel as it cuts the coal, and washes the cut coal rear-



ward under its belly with a small river of water. It moves forward on treads, and even has an extra set on top to give top-and-bottom traction for grades. Power is 100% electric: a 50 hp motor and two 8 hp motors drive the working parts. The two smaller motors drive the pumps.

Instead of corrugated or solid metal conduit for protection of wiring, what appears to be a close-spaced helical spring serves the purpose. The individual helical turns can be separated easily to expose the insulated wires.

Across-the-board standardization of control knobs is evident. Each knob is identical, resembling the handles on American valves (x and + sections), yet some must be turned, others pushed. The operator apparently has to memorize which. All controls are grouped conveniently at the rear.

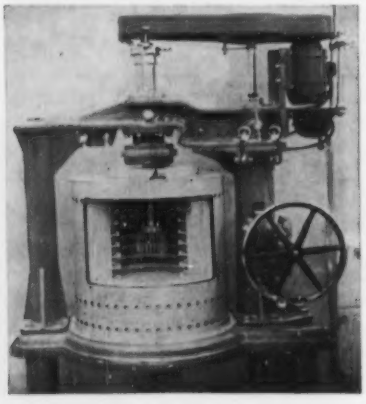
A profusion of nameplates indicates that motors, valves, gears and other accessories are purchased from many different plants. Soviet engineers say that catalogs are an important design tool in Russia. —Fank Yeaple

Test Equipment

Test equipment relies heavily on optics

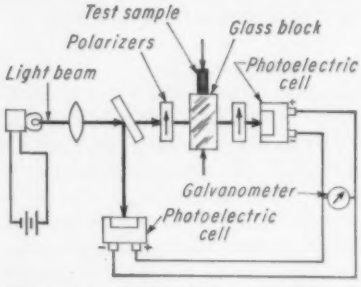
Optical test instruments . . . take up a large portion of optical section. Besides the more popular display of camera lenses, and telescopes, also shown were diffraction gratings and interferometers. The multiple-beam interferometers are highly precise instruments but with a pricetag to match. In this country they are generally limited to the manufacture of optical lenses or gage blocks which require accuracies in millionths of an inch. Of the two instruments set up, one measured flat surfaces and the other the trueness of a spherical ball bearing. They are based on the principle of interference between two parts of a split nomochromatic light beam. The first part of the beam is reflected off the surface of the test piece and then recombined with the original. Deviation is observed as interference bands or fringes. —Herb Kee

Stress-rupture . . . strength of high-temperature alloys is determined by this centrifugal creep tester. From 24 to 48 bar-shaped samples 3-4 mm dia are mounted on the rotating head shown here through the cutaway furnace. Rotating at speeds from 600 to 3600 rpm, various constant force fields can be easily set up to subject the samples to bending stresses from 1-80 kg/sq mm. Resistance furnace provides constant temperatures from 750-2200 F. Principal advantage: it can screen many samples in one test. —Ford Park



Relaxation properties of materials . . . at high temperatures are under study by the Russians using a new type test machine which uses a combination of photo, electrical and optical principles. The machine, developed by their Institute of Crystallography can automatically record stress-time curves of small-size test samples (2 mm dia x 3 mm length) in vacuum or protective gaseous fluid at temperatures of up to 1200 C. Specimens are usually plastics—but metals can be tested.

Here is how relaxation is measured.



The sample is placed on a much larger block of glass. Both are compressed to a desired over-all distance. This stresses both sample and glass. Stress in the glass is measured and automatically recorded by a "photoelectrooptical" dynamometer (above) in which a light source is split into two paths. The top path passes through a photoelastic setup in which the light is polarized and passed through the glass block. Stresses in the glass change the plane of polarization so that the polarized light is "filtered" by the second polarizer. The intensity of the emerging light is noted by the photoelectric cell which produces a voltage proportional to the intensity. To provide a datum line, a second light path is deflected downward into another photoelectric cell and the galvanometer measures in voltage between the two cells.

Key to the method is that if the test sample begins to relax when subjected to high temperature over a period of time, it will cause a proportional reduction in stress in the glass block because the clamping distance across the glass and specimen is kept constant. This reduction in stress is noted by the galvanometer which, through a separate system not shown, records a line on a slowly moving plate. Speed of the plate can be varied from 8×10^{-4} to 0.1 mm sec. This furnishes the time element necessary to produce a relaxation curve. —Nick Chironis

And in Addition

Item: It is interesting to note that the relaxation tester was built, tested and produced for distribution by the institute which also conceived and designed it. This seems to be a common practice in Russia. For example, the automatic coal-mining machines on display were designed, built and tested by an "Institute for Design of Coal-Mining Machinery" which has on its staff specialists in many fields, similar to our research institutes—the main difference being, however, that the Russian institutes furnish a completed product ready for mass production.

The institutes get appropriations from the government and buys components or equipment as necessary.

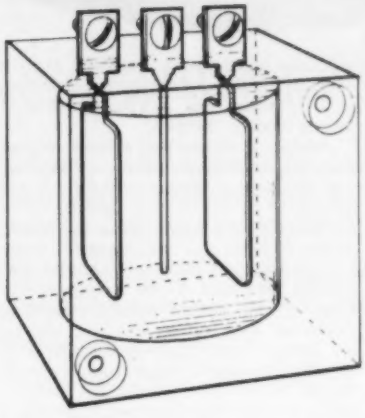
Item: We questioned several engineers from these institutes (who had accompanied their products as exhibitors) as to personnel changeover. It seems that one seldom changes field because he would lose status based on experience and thus draw less pay.

"Of course," said one engineer, "a man sometimes wishes to change because of the climate or because he has friends or relatives near another city. Why, then, he merely needs to write to the director of the institute he wishes to get to, stating his reasons, and request employment there"—a very formal procedure and one that obviously would deter people from job jumping. —Nick Chironis

Item: One quick way to tell the Zil-111 and Chaika cars apart (like Detroit's products, they tend to look alike and differ in power by only 25 hp) is to inspect the all-leather dust boots over the rear leaf springs. The Zil-111 has its boots strapped on with chrome-plated buckles, while the Chaika uses leather throngs. —Ford Park

Ac Static Switch Designed

DETROIT—First static switch for ac was unveiled here by the inventor, Stanford R Ovshinksy of Ovitron Corp. The switch, called "Electro-ionic," is essentially an acidic electrolyte conductor with two tantalum-oxide terminals controlled by a smaller third electrode—the "grid"—immersed in the electrolyte. Unlike other static elements, it switches the full ac sine wave without "chopping," half-wave rectification, or distortion. The Electro-ionic switch is claimed to be smaller than equivalent transistor, magnetic and electronic-tube devices in these power ranges.



The Ovitron design now in production switches currents from milliamps to about 15 amp, and voltages from a minimum of 3 to a maximum of 70 v. Switching time for 60-cps supply is about ¼ cycle on and 3 cycles off. Details of how it works and what it can be used for will be given in the next issue. ■

Foresees Many Uses for Radar-like Device

WASHINGTON—A tiny radar-like device that will detect and measure the speed of moving objects from a few inches to several thousand feet away has been demonstrated by the Military Products Div of the Singer Manufacturing Co. Known as Standing Wave Area Motion Indicator (SWAMI) the sensor is an ultra high frequency radio oscillator sealed in a vacuum tube.

The oscillator is pulsed for low frequency repetition. Any motion that occurs within surveillance of the device (normally it emits radiation over a 360 degree angle) causes a change in frequency. This change is sensed by an FM detector and induces a voltage fluctuation that touches off an alarm. Reflectors around the antennae will confine propagation to as small an angle as 15°.

When a SWAMI detector is positioned directly in line with the motion of a target, it will measure absolute speed. When not in direct line, it measures relative speed.

Because the device is versatile and costs considerably less than some present-day electronic detection systems, Singer expects wide military applications for the device in traffic control, battlefield surveillance and firing range safety equipment. Looking ahead, the company expects a variety of commercial applications where detection of moving objects is required. ■

Standards Awry Abroad

BOULDER, COLO—The US Air Force needs a way to calibrate electronic standards abroad with US standards, according to Col Richard Stolle of the Air Materiel Command, Wright-Patterson Air Force Base. When repairing equipment overseas, he said, the Air Force cannot always find standards that have been checked against counterparts in this country. Yet, extreme precision is essential when overhauling engines abroad.

Col Stolle made these comments during an inspection of the Boulder Laboratories of the National Bureau of Standards here. [*PE—June 22, p 38*] The labs opened last fall and provide calibration services for the armed forces, other government agencies and the electronic industry. Electric quantities ranging from zero frequency through the microwave region are within the labs' capability. All reference electronic standards at the Air Materiel Command are calibrated periodically at this NBS center. ■

COMING EVENTS

AUGUST

4-5 . . . . American Astronautical Society, 2nd Annual Western Regional Meeting, Ambassador Hotel, Los Angeles.

4-6 . . . . Society of Photographic Instrumentation Engineers, Annual Convention and Exhiborama, Ambassador Hotel, Los Angeles, Calif.

18-21 . . . . Western Electronic Show and Convention, Cow Palace, San Francisco, Calif.

23-25 . . . . American Society for Metals, Eastern New York Conference on Fracture of Engineering Materials, Rensselaer Polytechnic Institute, Troy, N. Y.

SEPTEMBER

10-11 . . . . Society of the Plastics Industry, Midwest Section Conference, French Lick Sheraton Hotel, French Lick, Ind.

20-25 . . . . Instrument Society of America, 14th Annual Conference and Exhibit, Chicago Amphitheater and downtown hotels, Chicago, Ill.

21-22 . . . . Steel Founders' Society of America, 57th Fall Meeting, The Homestead, Hot Springs, Va.

22-24 . . . . Armour Research Foundation and NUCLEONICS magazine, Industrial Nuclear Technology Conference, Morrison Hotel, Chicago, Ill.

23-25 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 4th Annual Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D. C.

23-25 . . . . Office Equipment Manufacturers Institute, Business Equipment Exposition, National Guard Armory, Washington, D. C.

28-Oct 1 . . . . American Welding Society, Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

Engineers Union Pioneers Mutual Fund

WASHINGTON — The Engineers and Scientists of America are sponsoring the first mutual investment fund to be started by a labor organization. Sale of the fund's shares will be limited to members of the ESA.

The fund will be managed here by American Diversified Mutual Securities Co., Inc. Investment advisor is Yates, Heitner and Woods, of St. Louis. ■

Reader To Editor...

Who Fathered Ac?

To the Editor:

The article on Westinghouse in the Jan 19 issue (p 5), and the ensuing correspondence in the Feb 16 and Mar 30 issues, induced me to look again in Volume 2 of *The Alternate Current Transformer* by Prof J. A. Fleming, the fourth issue of which was published in 1894. Without transformers we wouldn't have any ac distribution system and therefore some dates and names given in this early book may be of interest:

1856: Cromwell Fleetwood Varley, an Englishman, patented a core-type transformer with a closed iron core. Unfortunately for him, the dynamo-electric machine was not yet invented and so he fed his device from a dc battery through a reversal switch.

1878: G. B. Fuller, a New Yorker, received a patent for an ac lighting system with incandescent lamps connected in series. Had he not already died in 1869, he could have been the father of an ac system in which the lamps are "connected in parallel," which was, of course, the key of success. Such a proposition was found among his notes after his death.

1882: Goulard & Gibbs received a British patent for a transformer which was unfortunately made with an open iron core and for a lighting system in which an unlimited number of lamps were connected in series. Few people know, however, that the Goulard-Gibbs patent was invalidated after it was carried by two appeals to the House of Lords in 1890. The series-connected system did not work either.

—Andrew A Halacsy
Federal Pacific Electric Co
Newark, NJ

No Common American Heritage

To the Editor:

While the comments of the authorities who offered their views on the question, "Does America Have a Design Heritage?" (May 18, p 36) are well worth serious consideration, I think most of them have overlooked a rather important aspect. It is simply that America is still a nation of polyglot nationalities with diverse heritages. America has not existed long enough for a complete fusion of the multiple cultures brought to these shores throughout the mere 350 years since the first settlement at Jamestown. Large segments of our population are still only one or two generations removed from Europe. No one can disagree with the fact that the "typical American" exists only as a statistical average or mean. Consequently, Americans do not have a common heritage, except for the political structure derived from our Constitution.

No, our design heritage has not yet matured. First, there must be a sifting, selection, and recombination of ideas until one is found which wins widespread acceptance among Americans and, we may expect, it will only become truly American when it acquires a characteristic nature from further scientific and artistic contribution within modern America.

America is still seeking some consistent principle on which to build a common design tradition. I venture to predict it will ultimately be based on a dynamic functionalism derived from modern engineering studies of stress and the shaping of materials to distribute these for the most economical utilization of each component material. Tools (and practically everything Americans own, except pure art objects, are tools of one type or another) will acquire a vitally alive appearance, demanding to be put to work for the purpose which they are intended, and suggesting a pleasure of accomplishment that the user may enjoy by their use. Designers will take pleasure in lines which express a perfection of engineering and the American public will come to reject purposeless ornamentation as a deceptively false decoration which has been applied merely as a poor substitute for truly creative design. This trend is already obvious, as witness the criticism of the current "Detroit gingerbread" product. When the public demands better, then our enterprising industry will marshal its creative talent to meet the demand, and it is indeed reassuring that the demand is finding voice.

—T Grant Maple
Chief engineer
Thermosen Inc
Stamford, Conn

Metric System in South America

To the Editor:

Having read "Points of View" in your Mar 23 issue (p 30) about adoption of the metric system, I got the impression that some details about this system may be of interest to you:

A system of measurements is derived from three basic units: length, weight (or mass) and time. It is of no principal importance whether the first of these units has the length of a centimeter or of an inch, as long as the more complex units (volume, weight, energy, etc.) directly derive from it. This is the case in the metric system, resulting in its simplicity, while your system fixes most of its units independently one from the other.

Guess for yourself how many working hours your German and Russian competitors are gaining and how many mistakes they are avoiding while your workers and foremen fiddle with fractions.

You must have complex multipliers through all your system to convert a value from one unit into another, while the metric system does it by switching the decimal point. To convert psi in pounds per square foot you must multiply by 144, while the pressure of 1 kilo per square centimeter simply equals 10 tons per square meter. By the way, this is nearly identical with the atmospheric pressure at sea level, though by pure coincidence—one more agreeable feature of the metric system.

To transform gallons into cubic inches you multiply by 231, while liters convert into cubic centimeters by multiplying by 1000. You multiply acres by 43,560 to get square feet, while 10,000 times the hectares give square meters. So it goes all through your whole system and the only reason you are not sorry for the time and the money you lose in unnecessary calculations is that you have no means to estimate how much it is. But you know how much it would cost you to adopt the metric system, and so you prefer the unknown losses to the known investments, even though you could be sure to gain in the long run.

There would be a period of having the two systems simultaneously, but there is no mental strain in that, as we constantly experience here in Brazil. We get our machines from Europe as well as from the US. Volkswagen is producing its cars here on the metric system, while Ford and GM do it in theirs. We constantly live in the state of affairs that you would have to pass through during a period of change. We have learned that it is quite an interesting experience to know how other people have tried to measure the world, an experience that might even add a little bit to a mutual understanding.

—Alexius Hebra
Production manager,
Eutectic Soldas e Soldagens S/A
Sao Paulo, Brazil

Flowmeter for Milk

To the Editor:

This is to advise reader R. A. Neilson, who asks in the June 15 issue, p 56, "why don't they R & D flowmeters for the dairy industry?"

There is one. A Siemens-Halske meter is operating now in more than a thousand installations in this country. The distributor is TEA Inc, Flushing, NY.

—Jack Meyer
Los Angeles, Calif

• Our thanks to K. C. Roth who suggested a Bopp & Reuther meter and J. P. Russell who told us about Co-Engineering Co's flow meter.—Ed.

Omitted Publications

To the Editor:

In your Mar 30 issue, p 45, you featured "Engineer's Bookshelf" in which you gave your readers an excellent compilation of available books. On page 57, where periodicals are listed, we can not help notice that no Hitchcock publication was included. These are: *Machine and Tool Blue Book, Grinding and Finishing, Carbide Engineering, Assembly and Fastener Engineering,* and *The Plant.*

—V C Hogren
Hitchcock Publishing Co
Wheaton, Ill

• Our list of periodicals had of necessity to be limited to those which in the author's opinion were primarily design-oriented. This is, of course, subject to interpretation, and Mr. Hogren's obviously differs.—Ed.

CIRCLE NO. 27 READER SERVICE CARD→

style is stainless steel

Stainless Steel is the only surfacing material with a hard lustrous finish that is always in style, withstands exposure to all kinds of wear and has a low maintenance cost for the life of the building.

No other metal offers the freedom of design and fabrication, economy of care and the durable beauty that serves and sells like Stainless Steel.

McLOUTH STEEL CORPORATION, Detroit 17, Michigan

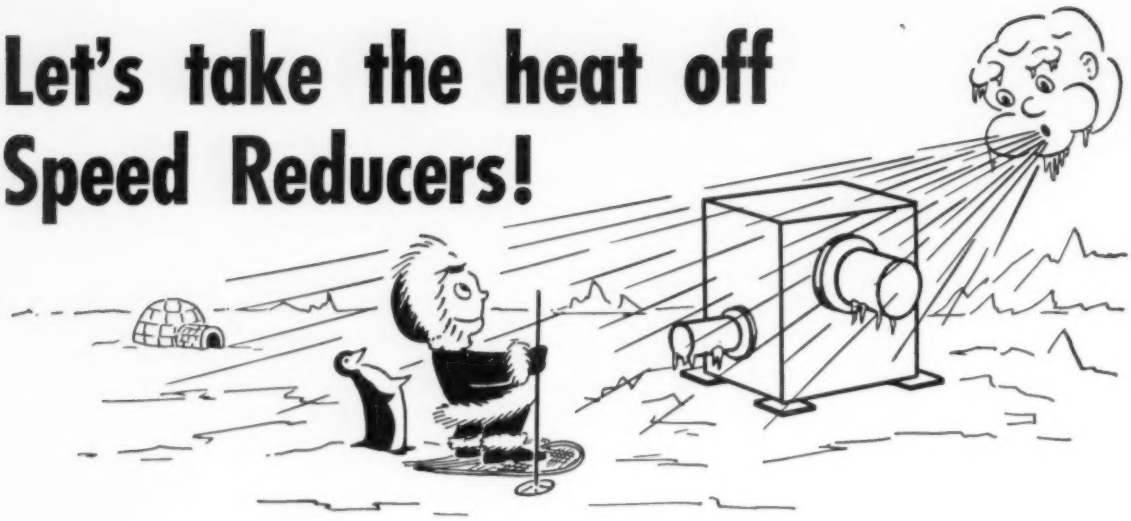
specify

McLOUTH STAINLESS STEEL

HIGH QUALITY SHEET AND STRIP

for architecture

Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

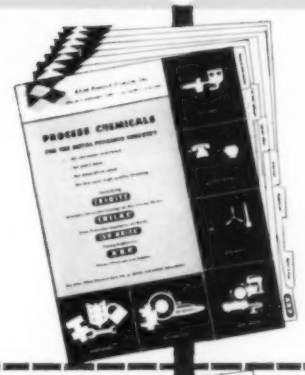
This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

FREE DATA FILES
on
Allied Research
LINES

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY

METAL FINISHING PROCESSES

A complete line of quality products and processes developed primarily as a result of helping manufacturers like yourself solve their metal finishing problems. If one of our present products does not meet your needs, we'll be glad to work with you to find an answer to your problem.



IRIDITE® Chromate Conversion Coatings for Non-Ferrous Metals.

IRILAC™ Clear Protective Coatings for All Metals.

ISOBRITE® *Chemically Different* Plating Brighteners.

ARP® *Process chemicals.*

EQUIPMENT AND COMPLETE SYSTEMS
for Metal Finishing

Process Engineered—Single pieces of equipment or all equipment necessary for a finishing operation—evaluated, designed, fabricated, installed and tested to match exactly your particular process. Ask about our *Process Engineering Service.*

WAGNER RECTIFIERS

Silicon and Selenium, built to exacting specifications for long life, trouble-free service.

WAGNER AUTO-LOADERS

for fast, economical transfer of racks and parts, conveyors to plating machines, between conveyors.

AUTOMATIC AND SEMI-AUTOMATIC PLATING MACHINES

BARRELS, TANKS and other equipment.

CHEMICALS AND SUPPLIES

Prompt service on a wide variety of daily-use necessities for the plating room, delivered from warehouse stocks strategically located in cities in metalworking areas.

FLAT-TOP® **ANODES** in copper and zinc.

LECTROCOP® **FLAT COPPER ANODES**

CADMIUM, WHITE BRASS AND TIN ANODES in most efficient shapes. Acid Replacements, Buffs, Chemicals, Cleaners, Maintenance Materials.

NICKEL RECASTING SERVICE

Ask your Allied Field Engineer about our Subscription Plan which combines your new nickel purchases with a service to recast *your* butts and spears, resulting in substantial savings.

Allied Research Products, Inc.
4004-06 EAST MONUMENT STREET
BALTIMORE 5, MARYLAND
Branch Office: 400 Midland Avenue, Detroit 3, Michigan
Chemical and Electrochemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing.

WRITE TODAY FOR COPIES of those useful files describing technical details of our complete line, OR, phone your Allied Field Engineer. He's listed under "Plating Supplies" in your 'phone book.

DOW

PLASTICS PLAY LEAD IN NEW SALES SEASON

Rapid-fire developments in versatile thermoplastic materials herald sure-fire successes on the sales front. As the new products make their public debut, plastics are increasingly conspicuous by their presence. These chemically engineered materials are lightweight, yet strong and durable. They save pennies on the production line, look like a million in the show window.

Take Verelite*, newest in the fast growing Dow lineup of polystyrene materials. Designed specially for interior lighting applications such as grids and diffusers for fluorescent fixtures, it is light stabilized offering superior resistance to yellowing. It is now available in several different granulations for both extrusion and molding.

*TRADEMARK

LIGHTWEIGHT STYRON MAKES VACUUM CLEANER SALES HUM

Dow thermoplastic replaces other materials, delivers production economy, attractive appearance.

The manufacturer of the compact vacuum cleaner shown below put plastics to full use in redesigning his product. The result is a lightweight, extremely portable and attractive unit that stimulates sales and gives the production man fewer headaches.

Styron® 475, one of Dow's high impact thermoplastics, was used for the housing and other rigid parts. The flexible parts are vinyl. The cleaner is available in two models, one for the home (pictured below) and one for industrial use. Lightweight Styron 475 makes the industrial version ideal for cleaning radio tubes, electronic equipment, electric motors and other products with hard-to-get-at corners and crevices.

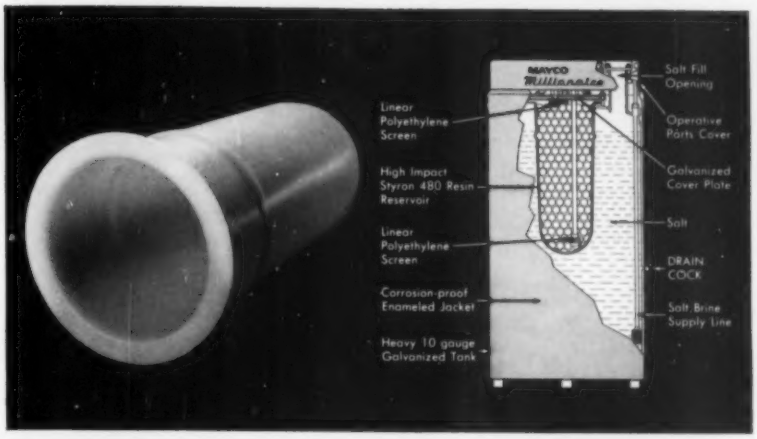
In addition to a smartly styled appearance and a wide selection of colors, Styron 475 provides a warm touch pleasing to housewives. Compared to materials previously used, it trims costs by eliminating several fabrication and assembly operations. Like all Dow plastics, it gives the designer broad latitude and its quality is consistent and uniform. This contributes to greater production efficiency and fewer rejects.

This compact, time and effort saving portable vacuum cleaner lightens the work of the housewife and the maintenance man. Its components are molded of tough, versatile Styron 475.

PLASTICS PERFORM

when pressure's on

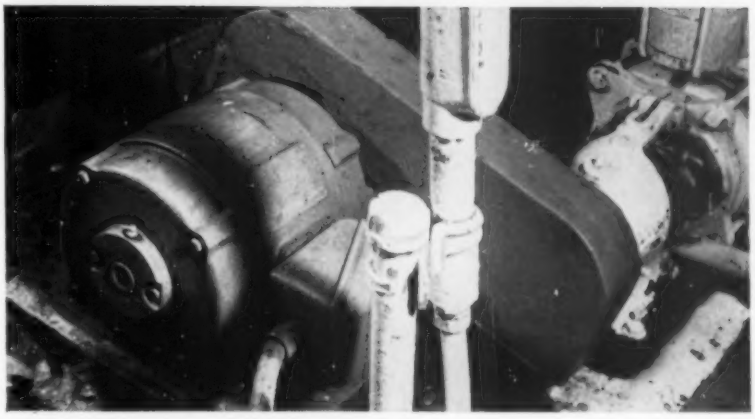
This water softener creates a vacuum in its recharging cycle, producing up to 120 lbs. pressure on every square inch on the surface of the tank. That's one of the many reasons Styron 480, Dow's *extra* high impact thermoplastic, with its great strength was chosen for the job. As Styron is rustproof, there are no corrosion problems. The excellent moldability of Styron helped in making this large, thick-walled reservoir. This application is typical of many developed for manufacturers by a plastics molder offering integrated design and production services.



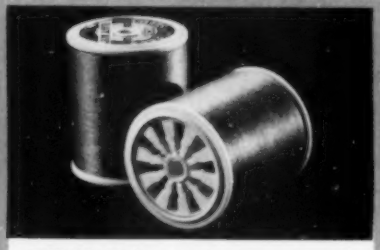
ACID VAPORS

can't hurt this motor!

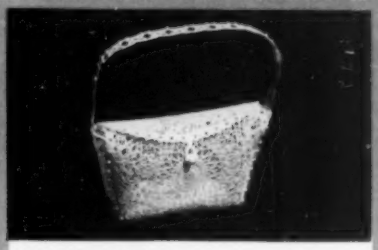
This electric motor is located in a most unfavorable position—right in the middle of a chlorine plant. But the highly corrosive vapors and the ever-present moisture can't get at the vital parts because they're fully encased in a tough protective bed of epoxy resin. The motor has been in service more than two years without a single failure. Dow Epoxy Resins give greater over-all protection to all types of equipment because of high purity, rigid specifications and production dependability.



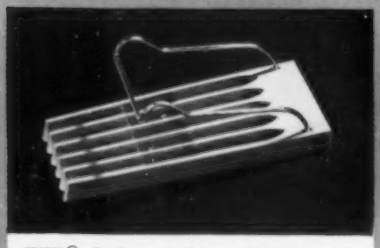
FOUR DISTINCTIVE PRODUCTS MADE OF DOW THERMOPLASTICS



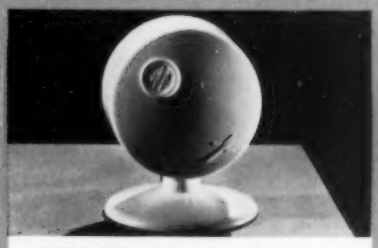
STYRON 475. Even the time-honored thread spool can be improved by plastics! No wood grain imperfections to worry about in smooth-surfaced, colorful Styron 475.



POLYETHYLENE. The extremely intricate mesh design of this Communion bag thoroughly demonstrates the excellent flow characteristics of Dow Polyethylene 990M.



TYRIL®. Tyril, a copolymer of styrene and acrylonitrile, provides rigidity, craze resistance and freedom from cracking in this unique pants hanger.



STYRON 475. Fine surface gloss, impact resistance, color selection and excellent electrical properties make Styron 475 ideal for this indoor TV antenna housing.

FOR MORE INFORMATION

. . . about the versatile Dow plastics and the products discussed on these two pages, write to us today. THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. 1701DZ7-20.

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW

Industrial molding materials

●

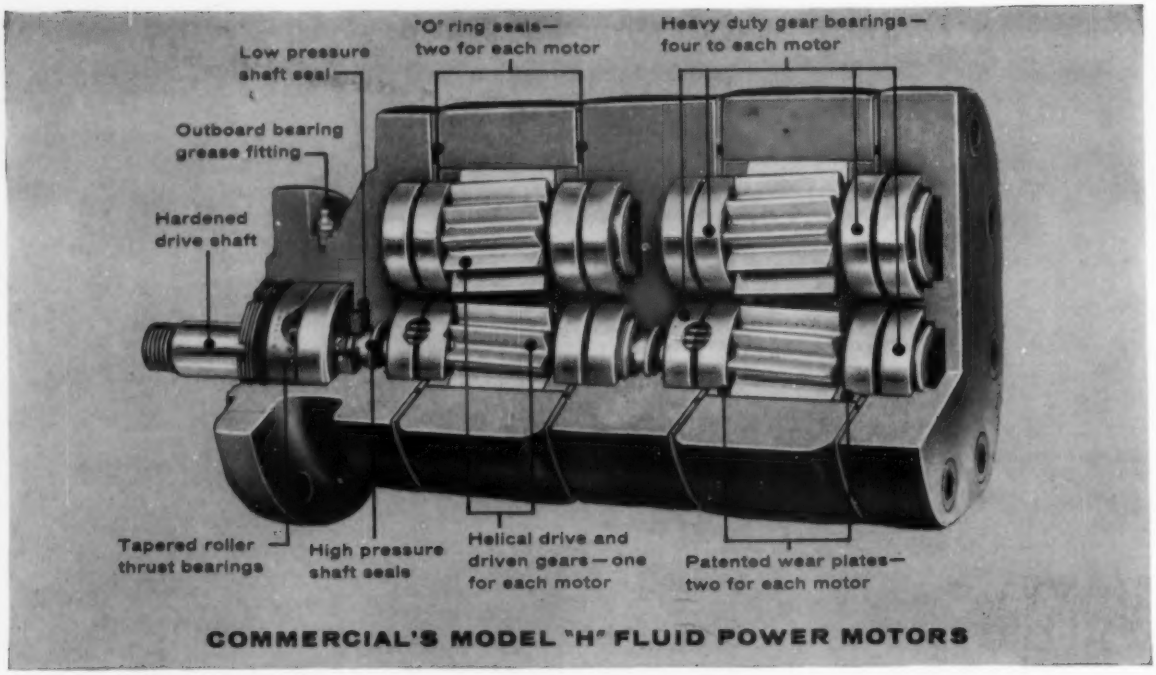
Packaging materials

●

Paint and coating materials

●

Building products



COMMERCIAL'S MODEL "H" FLUID POWER MOTORS

New ideas in fluid power motors

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. One single motor having three-inch gears operating at 1600 psi at a speed of 1200 rpm would develop about 50 h.p. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

Engineering help available

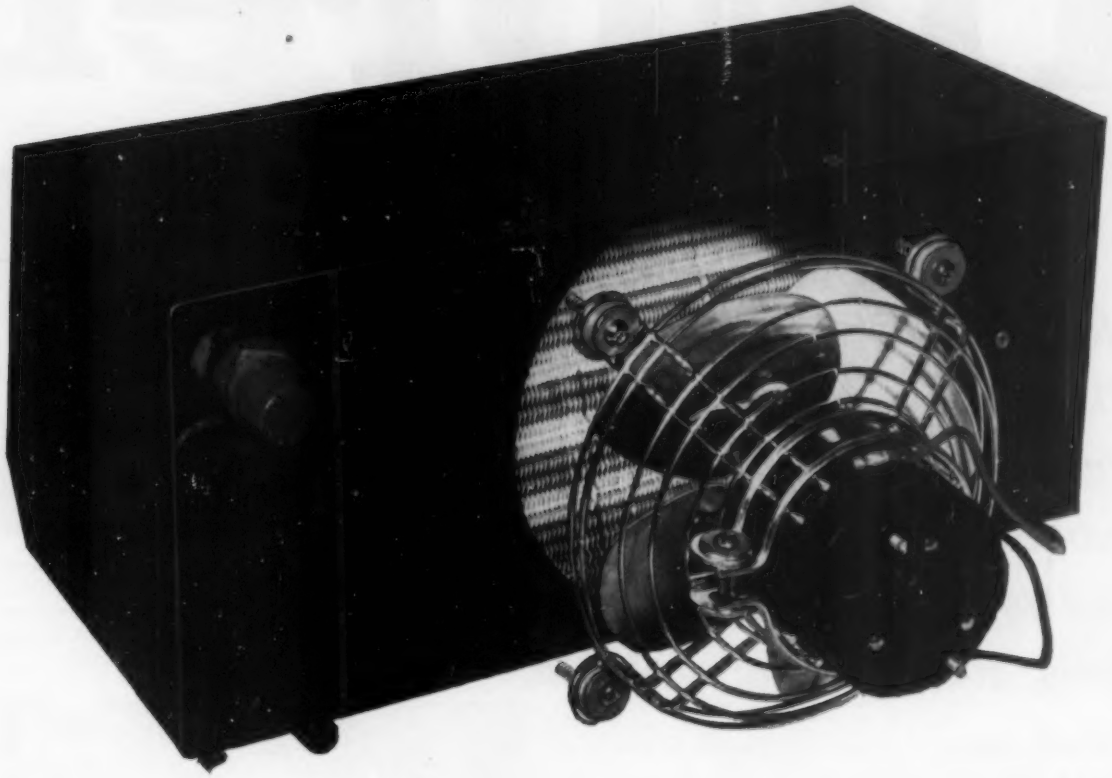
Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is technical help and assistance from Commercial on fluid power applications.

Address inquiries to The Commercial Shearing and Stamping Company, Dept. G-30, Youngstown 1, Ohio.

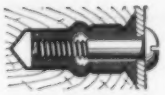
COMMERCIAL
shearing and stamping

B.F.Goodrich

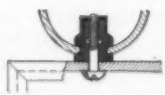
RIVNUTS® speed assembly of Frigette car air conditioner



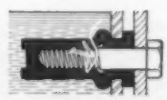
IN THIN SHEET METAL
B.F.Goodrich Rivnuts provide firm, accurate nutplates with clean threads. Eliminate pulling or tearing of thin metal. Can be installed after enameling!



IN WOOD – Splined Rivnuts give 6 clean threads for attachment, eliminate wood screws. Bulge formed by upsetting anchors Rivnut in wood. Splined shank prevents turning.



IN TUBING—In blind applications, B.F.Goodrich Rivnuts hold firmly and permanently because bulge in Rivnut conforms to curvature of the tube.



IN TANKS – Rivnuts with closed ends make a 100% liquid-tight seal. Rivnuts provide nutplates that are not loosened by shock or vibration.

B.F.Goodrich Rivnuts have proved "the most complete answer" to a fastening problem at Frigiquip Corporation, manufacturers of Frigette automotive air conditioners. In more than 25,000 applications there has never been a failure.

The problem was to attach fan guards to evaporator cases as quickly and efficiently as possible – without welding. Fan guards had to be easily removable for servicing.

Solution? Simply punch four holes in the evaporator case and install the Rivnuts. Then fasten the fan guard to the Rivnuts with screws. Rivnuts form solid nutplates that stay put when service mechanics remove the fan guard.

B.F.Goodrich Rivnuts cut costs and assembly time in many jobs. (See examples at left) For help in solving your own tough fastening problems, call in *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-79, Akron, Ohio.*

B.F.Goodrich
aviation products

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS

fluorel*

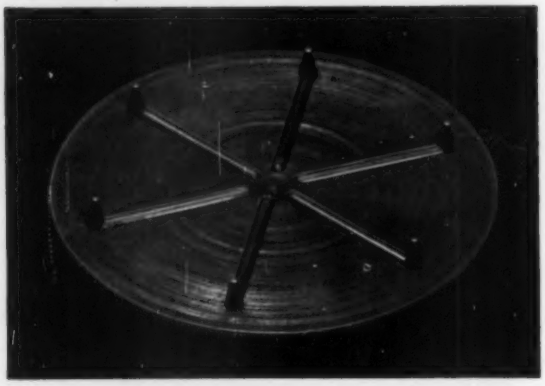
BRAND ELASTOMER

New FLUOREL Brand Elastomer is a highly fluorinated synthetic rubber that successfully resists corrosive chemicals, fuels, solvents, and ozone

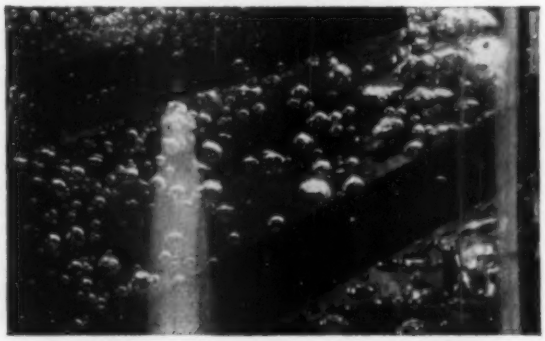
FLUOREL Elastomer is rated for continuous long-time service at 400° F . . . tolerates 600° F temperatures, and higher, for reduced periods under some service conditions. Ease of processing, non-combustibility, and excellent resistance to compression set are other outstanding features.

FLUOREL Elastomer greatly extends the performance range of applications requiring elastomeric materials. Its many exciting possibilities make it an important member of the ever-expanding family of 3M organic fluorine compounds. For complete data, write: 3M, Chemical Division, Dept. KAS-79, St. Paul 6, Minn.

*The term "FLUOREL" is a trademark of Minnesota Mining and Manufacturing Company.



EASE OF PROCESSING is shown by this disc. Note the reproduction of machine marks from mold surface. FLUOREL Elastomer can be readily mold processed on standard rubber compounding and fabricating equipment. It may be molded, extruded and bonded to most metals.



WHEREVER THE HEAT'S ON, put FLUOREL Elastomer to work for you. It's in use now or under evaluation in the missiles and aircraft, automotive and chemical processing industries for oil seals, "O" rings and gaskets. Other suggested uses: fire walls, air ducts, fuel cells, fuel and hydraulic hose, diaphragms and tank linings.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

titeflex flexible hose made for the toughest design jobs

It is now possible to design fluid transfers that would have been impossible until recently. Here are examples of TITEFLEX advances in the flexible hose field:

ITEM: Springfield "400"* Teflon** hose in diameters to 2" . . . convoluted by an exclusive process to produce unique flexibility . . . minimum bend radius only 3½ times hose diameter!

ITEM: "Zero-motion" braiding . . . a TITEFLEX process that also reduces chafing of braid wire, and wear to minimum. Elongation or contraction at operating pressure less than ⅛ of 1%!

ITEM: Springfield "140" Teflon Hose Assemblies . . . with reusable fittings . . . factory or field installed!

ITEM: Springfield "110" Teflon Hose Assemblies . . . guaranteed against fitting blow-off at their specified temperatures and pressures!

TITEFLEX is found wherever design problems are toughest. Details and specifications are as close as your phone. Your TITEFLEX distributor is in the yellow pages, or contact TITEFLEX direct.

titeflex

*T.M. of Titeflex, Inc., Patent Pending **Reg. T.M. of duPont

titeflex inc. springfield mass. PACIFIC DIVISION • SANTA MONICA • CALIF

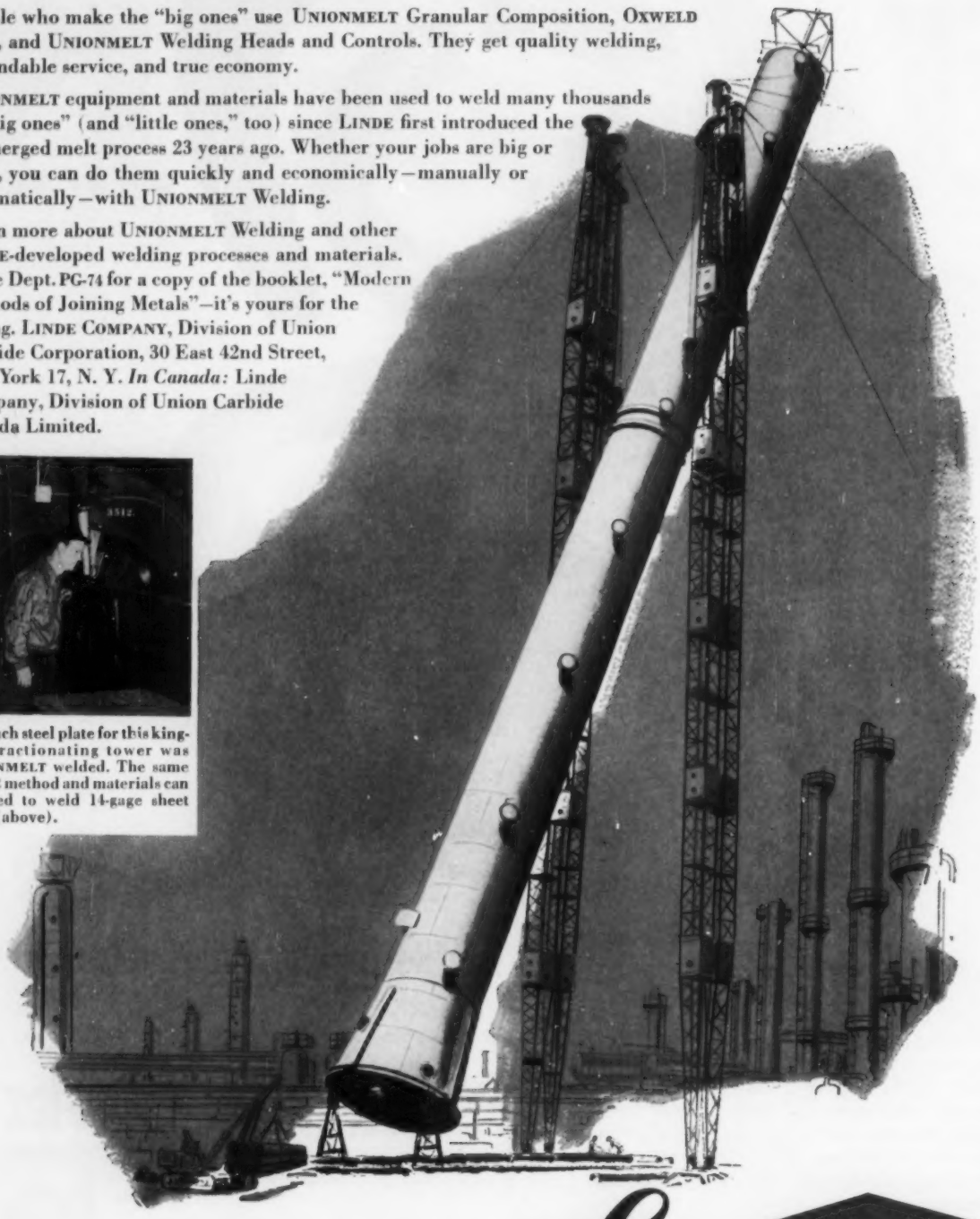
UNIONMELT Welding
makes short work of tall towers

People who make the "big ones" use UNIONMELT Granular Composition, OXWELD Wire, and UNIONMELT Welding Heads and Controls. They get quality welding, dependable service, and true economy.

UNIONMELT equipment and materials have been used to weld many thousands of "big ones" (and "little ones," too) since LINDE first introduced the submerged melt process 23 years ago. Whether your jobs are big or little, you can do them quickly and economically—manually or automatically—with UNIONMELT Welding.

Learn more about UNIONMELT Welding and other LINDE-developed welding processes and materials. Write Dept. PG-74 for a copy of the booklet, "Modern Methods of Joining Metals"—it's yours for the asking. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

One-inch steel plate for this king-size fractionating tower was UNIONMELT welded. The same LINDE method and materials can be used to weld 14-gage sheet steel (above).



Linde

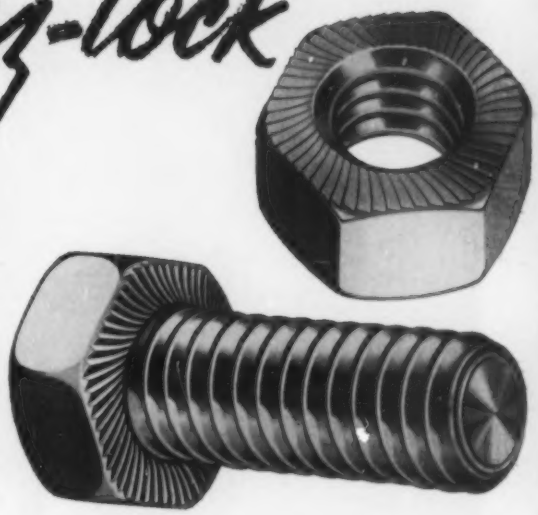
UNION CARBIDE

The terms "Linde," "Unionmelt," "Oxweld," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Fascinating Fastener...

An exciting new and secret project dubbed "operation buzz nut" by plant and office employes is now revealed as a unique and fascinating idea in fasteners—MacLean-Fogg's new *Whiz-Lock*.

the M F whiz-lock



STARTLING RESULTS

Out of M-F research and development labs has come a lock nut that has amazed even those who first conceived it. A free-spinning surface-bearing lock and tension nut which surpassed expectations even in the earlier models.

The Whiz-Lock principle (an entirely new concept in fastening) has been a well-kept secret for over a year. Now patent applications are in—and this startling device is ready for designers, engineers and production men to uncover new properties and uses for this amazing fastener.

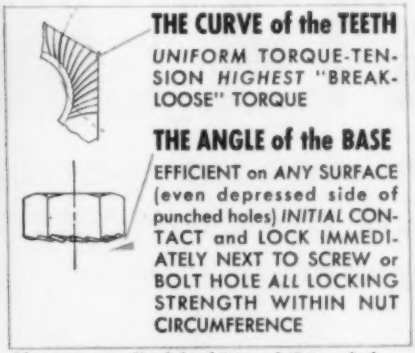
LOW COST, TOO

Whiz-Lock was released *only* when its *design* was capable of *precision* manufacture on conventional machinery. Thus *Whiz-Lock* is NOT a premium-priced nut!

Try this amazing Whiz-Lock test for yourself!

Apply, a common nut with as much torque as you can. Torque to release it doesn't even reach application torque.

Now spin on a Whiz-Lock, tighten—and try to break it loose! (Caution: do not attempt on glass-top or light-weight desks.)



THE CURVE of the TEETH

UNIFORM TORQUE-TENSION *HIGHEST* "BREAK-LOOSE" TORQUE

THE ANGLE of the BASE

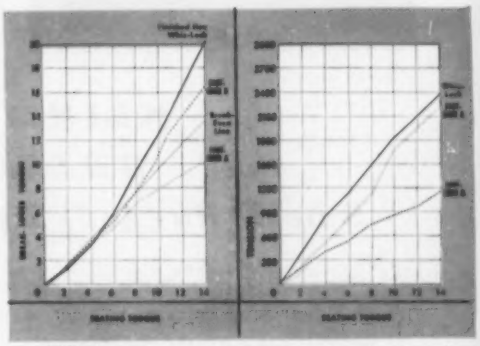
EFFICIENT on ANY SURFACE (even depressed side of punched holes) *INITIAL* CONTACT and LOCK IMMEDIATELY NEXT TO SCREW or BOLT HOLE ALL LOCKING STRENGTH WITHIN NUT CIRCUMFERENCE

.The unequalled locking ability of the Whiz-Lock is only one of its many advantages to designers, engineers and production men.

• One piece • Free spinning • Very high tension • High strength—heat treated • High re-useability • Consistent—uniform torque tension • Highest release torque to application torque • Low cost

ON-and-OFF-TORQUE RATIO CHART

TORQUE-TENSION CHART



NOTE the excellent torque-tension and "apply and release" ratio of the M-F Whiz-Lock in *both* tests.

For oversize holes or wherever flange use is indicated, the same WHIZ-LOCK principle is available in flange nuts and screws.

SEND FOR BROCHURE...information on sizes and dimensions...M-F Whiz-Lock Nuts and Screws and M-F Flange Nuts and Screws

patents pending

MACLEAN-FOGG LOCK NUT COMPANY

5535 N. Wolcott Avenue • Chicago 40, Ill. • EDgewater 4-8420

IN CANADA: THE HOLDEN CO., LTD., MONTREAL

CIRCLE NO. 37 READER SERVICE CARD

PLAIN CUP MOUNTING
FORMED CUP FOR MOUNTING ON TUBING
FLANGED CUP FOR FLAT SURFACE MOUNTING
NEW
THERMOSTATS ILLUSTRATED IN FULL SIZE

KLIXON 20420 SERIES SEALED THERMOSTAT

Small, Rugged, Dependable Controls at LOW COST

The new KLIXON 20420 line of thermostats offers high quality performance at low cost, particularly in applications involving refrigeration, air conditioning, heat pumps, where sealed construction with heavy duty electrical switching is required.

Like other Spencer disc type controls, the KLIXON 20420 gives inherently snap acting thermostatic response, with fixed temperature settings calibrated at the factory to meet specific application needs.

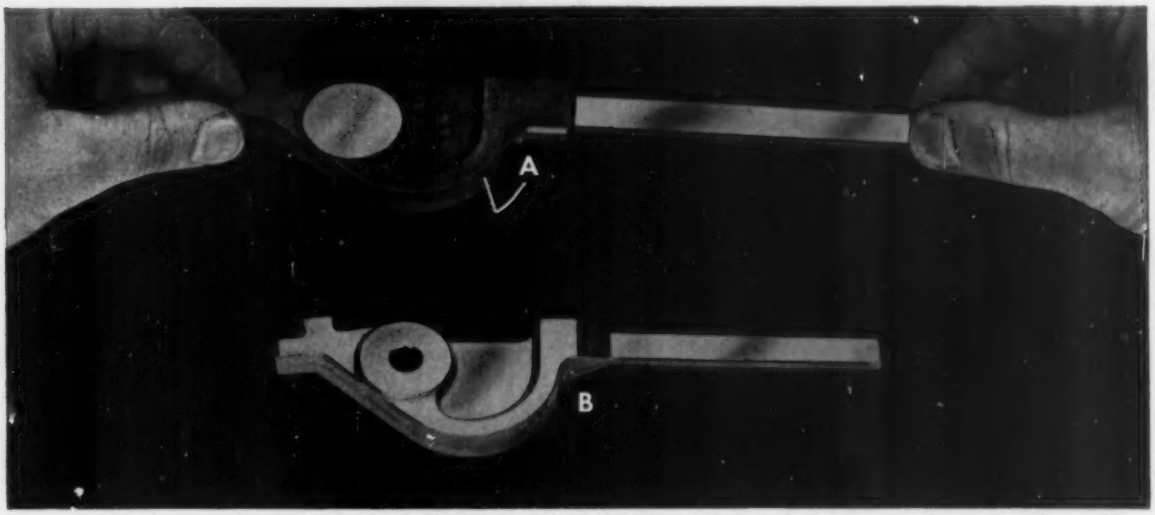
SPST and SPDT switching are available in automatic reset types. Switch action is clean and dependable, even when subjected to shock and vibration, and is unaffected by mounting position.

The KLIXON 20420 line is contained within a copper cup for rapid temperature transfer, with choice of bottom flange for flat surface mounting or formed cup for mounting directly on tubing as illustrated above. Sealing is accomplished with baked epoxy resins to exclude air-dust-moisture. Full details in Technical Data Bulletin THSN 22 available upon request. Write:

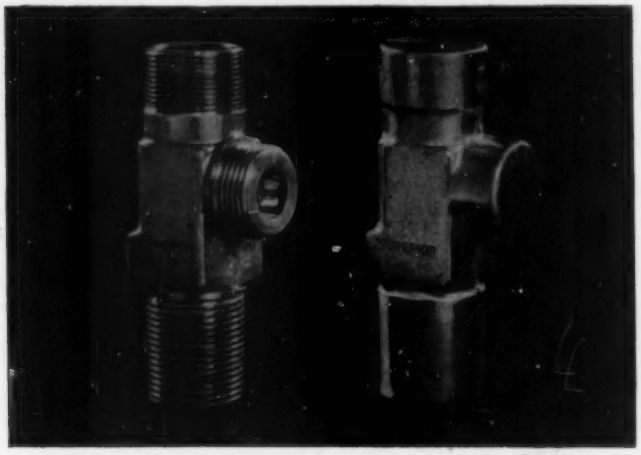
METALS & CONTROLS
3807 FOREST STREET, ATTLEBORO, MASS., U.S.A.
A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

QUALITY CONTROL PLUS SAVINGS Value analysis suggested the use of a die-pressed forging. The result: an 85% cost reduction and a stronger, tougher part.



SWITCH BLADE in overspeed limiting device on large General Electric motor-generators was originally an assembly **A**—an arm brazed to a brass casting which was machined, slotted, and drilled. After review in the company's Value Analysis program, assembly was replaced by Anaconda die-pressed brass forging **B**. The superior strength of twice-wrought metal made possible a one-piece part. The excellent finish and consistent dimensional accuracy of the die-pressed forgings eliminated all machining but the drilling operation. The over-all cost is 15% of the original part.



VALVES FOR CHLORINE AND FLUORINE shipping containers must have unusual corrosion resistance and high strength. Superior Valve & Fittings Co., Pittsburgh, specialists in handling halogens, looked for a forging alloy that would be suitable. American Brass Company metallurgists suggested die-pressed forgings of a slightly modified Everdur®-1014, an aluminum-silicon bronze, for this chlorine-fluorine service, and this customer is finding wide use for it in other severe service, too. The twice-wrought metal of Anaconda die-pressed forgings has dense structure to prevent leaks—strength and toughness to take rough handling. Yet it can be machined in automatic-chucking machines resulting in good cost control.

THE vital job of controlling quality *and* costs may be easier than you think. Anaconda technical specialists will gladly help you find the right alloy and mill form to do both. See your American Brass Company representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 8040

DIE-PRESSED FORGINGS SPECIAL-SHAPE TUBES
EXTRUSIONS FABRICATED METAL PARTS

products of

ANACONDA®

made by The American Brass Company

Motors Thrive on FREQUENT OVERLOAD ABUSE!

Brunswick D-31 Precision Bowling Lane Sanders
Powered by Lightweight R&M 8 HP Single Phase Motors

The Brunswick-Balke-Collender Company recently handed ROBBINS & MYERS an unusual motor problem when it re-powered the Brunswick D-31 precision bowling lane sander. The D-31 cuts across 250 square inches of area in one continuous cutting operation. Motor must withstand frequent and severe overloads when the machine levels high spots in the alley bed. Power had to be single-phase, too, because many bowling establishments carry only single phase current! To keep sander truly portable and easily maneuverable . . . and to protect lanes from excess weight, motor had to be lighter than ordinary single-phase motors.

ROBBINS & MYERS custom-designed an 8 HP capacitor-start, capacitor-run motor that is daily proving its stamina against these rugged requirements. Should more power be needed, design includes provision for adding an auxiliary blower which can conveniently increase capacity to 10 HP. Weight was kept down by using special aluminum end heads. For easier maintenance, the extended end-head housing can be removed quickly and easily to expose condensers and centrifugal switch.

Many other features insure longer life for *every* R&M motor: double width bearings that have extra-large grease capacity . . . Mylar* insulation with 8 times the dielectric strength and 35 times more moisture resistance than ordinary paper insulation . . . removable caps for quick bearing inspection and relubrication . . . end heads that give full-height protection . . . dual-sweep ventilation for efficient cooling.

For motors to meet unusual challenges . . . and for standard motors, always contact ROBBINS & MYERS! Write today for Bulletin 470PRF!

**DuPont registered trademark*

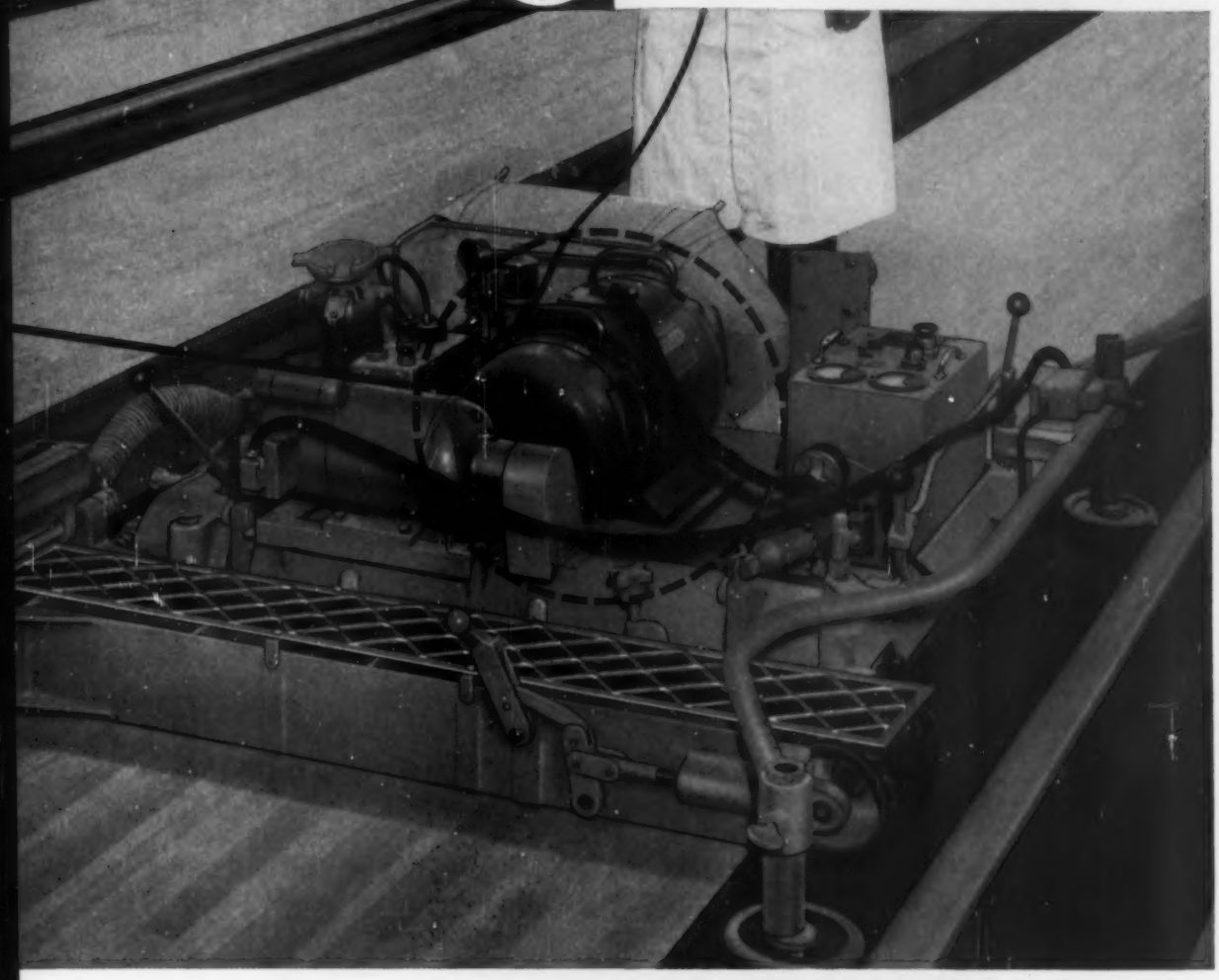
ROBBINS & MYERS, INC.

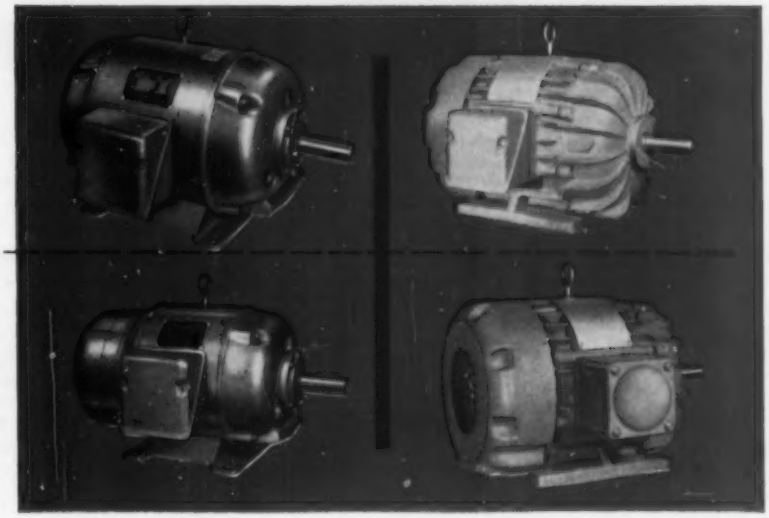
motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

MOTORS 1 thru 200 HP

(other ratings 1/200 to 1 horsepower)





Open Protected Motors (left), up to 200 HP, are suitable for many applications formerly requiring totally enclosed construction.

Totally Enclosed Motors (right), ½ to 200 HP, are fan-cooled . . . offer complete protection against all harmful atmospheres.

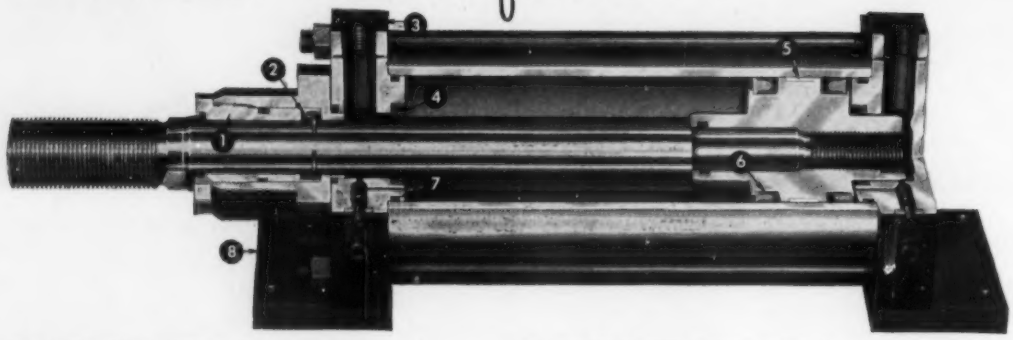
"PM" Single Phase Motors (left), ratings through 20 HP, eliminate maintenance because they are fully weatherized for severe duty.

Explosion-Proof Motors (right), ratings through 200 HP, are Underwriters' Approved for Class I, Group D, and Class II, Groups F & G.

CIRCLE NO. 41 READER SERVICE CARD

Announcing Valvair®

Check these Valvair features...



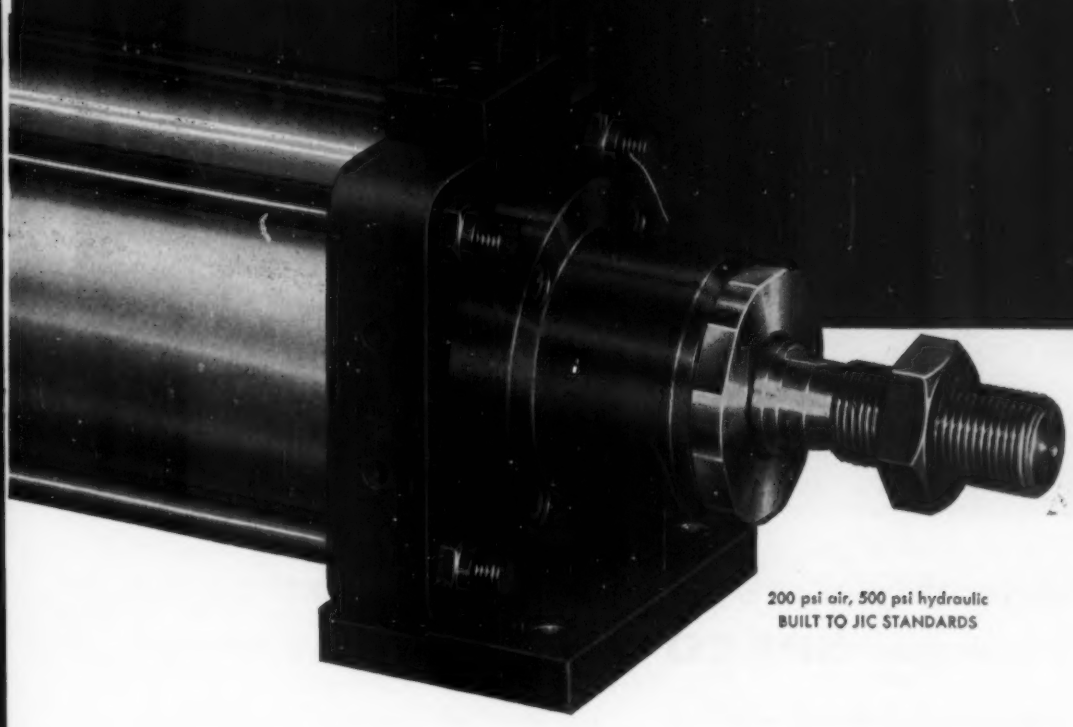
1. **EXTRA-LONG NOSE GUIDE** provides maximum bearing area for piston rod . . . assures peak resistance to side-loading deflection of rod and piston.
2. **CARTRIDGE SEAL** assembly is designed for quick on-the-machine servicing . . . can be replaced without any disassembly of the cylinder.
3. **REMOVABLE PORT ADAPTERS** allow fast exchange of complete cylinder assemblies for bench servicing . . . time consuming piping operations are eliminated.
4. **SELF-ALIGNING CUSHION SEALS** assure uniform cushioning throughout cylinder life . . . unique one-way seal eliminates need for cushion ball check.
5. **TEFLON* WEAR STRIP** on piston prevents metal-to-metal contact between piston and bore . . . scuffing or scoring of bore surface cannot occur.
6. **NYLON-BACKED PISTON CUPS** for air service, or Teflon-backed O-rings for hydraulic applications, provide positive, bubble-tight sealing throughout the cylinder's operating pressure range . . . keeps break-loose pressures low.
7. **POSITIVE BARREL SEAL,** with full-width metal-to-metal contact between barrel and heads maintains leak-free sealing . . . holds dimensional stability under maximum stress.
8. **RE-USABLE MOUNTS,** with precision-fit load bearing slots, handle heaviest operating loads with ample safety factor . . . are easily changed for modification or re-use of cylinder.

*Trade name for duPont tetrafluoroethylene resin

8029

VALVAIR AIR & HYDRAULIC CYLINDERS • SPEED KING CONTROL VALVES AND MANIFOLDS • PLUG-IN CONTROL VALVES AND MANIFOLDS

HEAVY-DUTY AIR AND HYDRAULIC CYLINDERS



200 psi air, 500 psi hydraulic
BUILT TO JIC STANDARDS

Here is a cylinder on which you can stake your reputation . . . built by Valvair, makers of famous SPEED KING control valves. With design features based on years of application engineering experience in high-production manufacturing operations, Valvair's new heavy-duty air and hydraulic cylinder offers performance, durability and ease of maintenance. Construction and component materials have been coordinated to assure efficient, trouble-free operation, plus longest service life with minimum machine downtime.

Built to JIC Standards and offering a full range of bore and rod sizes, interchangeable mounting styles, stroke lengths and cushioning options, you'll find Valvair heavy-duty cylinders ideal for your non-rotating cylinder applications. Take advantage of one-source responsibility for all your control system needs . . . cylinders, valves, manifolds, filters, regulators and lubricators . . . call in your nearby Valvair field engineer today.

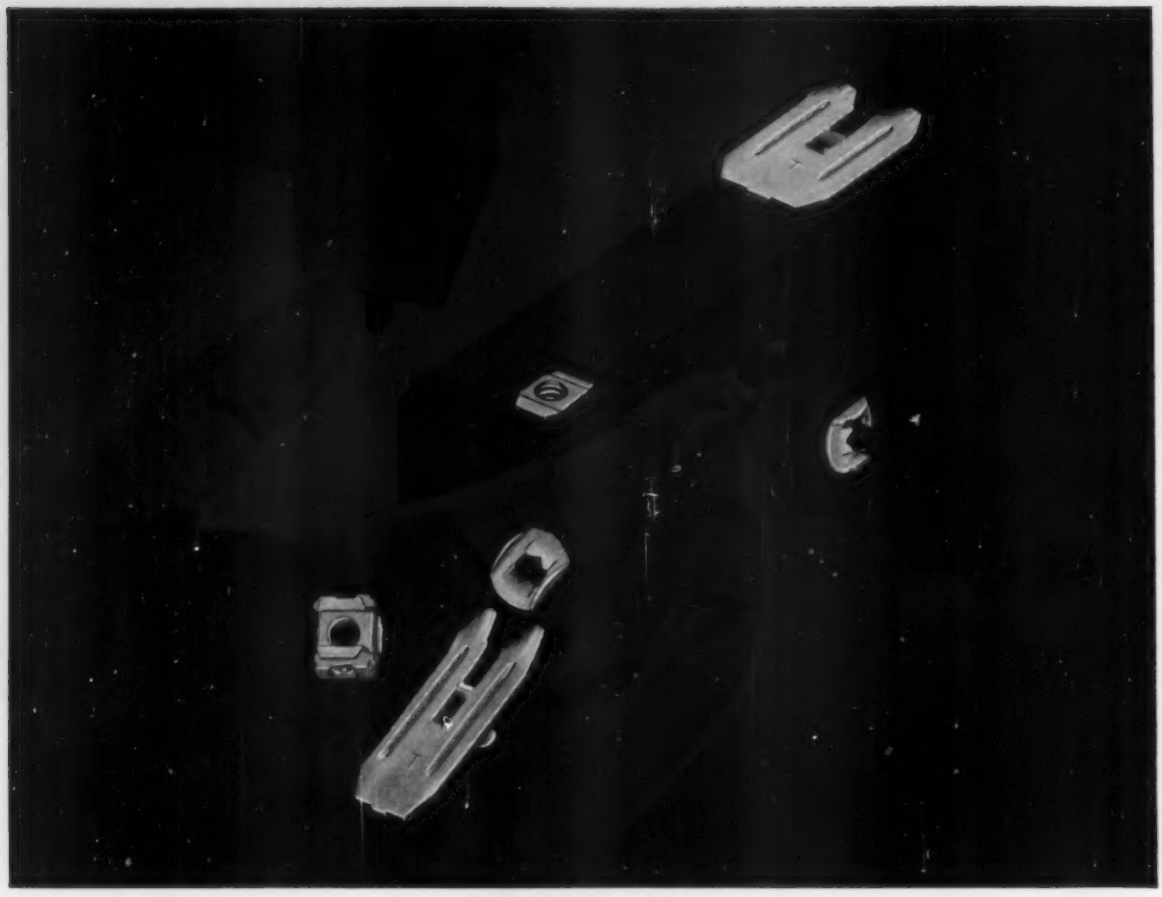
For detailed information, write for Bulletin VC-800, Address Dept. PE759, Valvair Corporation, Akron 11, Ohio.

Offices in principal cities.

Valvair AKRON 11, OHIO

Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

• HI-SPEED INLINE VALVES • PILOT VALVES • MINI-KING VALVES • MANUAL VALVES • FILTERS • REGULATORS • LUBRICATORS



Assembly costs cut 50% at design stage by Tinnerman **SPEED NUT**® Brand Fasteners!

Fastener ideas worked out between designers at Hillside Metal Products, Inc., and Tinnerman engineers, resulted in the selection of 3 different SPEED NUT types for Hillside's complete line of quality steel office furniture. Hillside estimates "at least a 50% saving in material costs, assembly time and tooling" over ordinary fastening methods. And spring-steel SPEED NUTS hold tight, even through years of hard service.

A special Dart-Type SPEED CLIP® snaps into a punched hole, securely anchors one end of the drawer latching mechanism spring. A standard Push-On SPEED NUT "bites" into a stud; prevents the other spring end plus latching bar from backing off. Desk tops as well as desk and table legs, are attached with the help of SPEED GRIP® Nut Retainers that snap into bolt-receiving position in punched holes. A Push-On completes the file drawer follow block assembly; two more secure each filing cabinet drawer card holder.

This should give you an idea of what a free Fastening Analysis can probably do for you in savings and improvements on present or new products. Look up your Tinnerman representative in the Yellow Pages under "Fasteners". Or write to

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd, Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd, Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Bundy GmbH, Heidelberg.

Product Engineering HORIZONS

July 20, 1959

50 ENGINEERING REASONS WHY NOT

A check list for the busy executive

1. We've never done it before.
2. Nobody else has ever done it.
3. It has never been tried before.
4. We tried it before.
5. Another company tried it once.
6. We've been doing it this way for 25 years.
7. It won't work in a small company.
8. It won't work in a large company.
9. It won't work in our company.
10. Why change—it's working OK.
11. The boss will never buy it.
12. It needs further investigation.
13. Our competitors are not doing it.
14. It's too much trouble to change.
15. Our company is different.
16. The ad dept says it can't be done.
17. The sales dept says it can't be sold.
18. The service dept won't like it.
19. The janitor says it can't be done.
20. It can't be done.
21. We don't have the money.
22. We don't have the personnel.
23. We don't have the equipment.
24. The union will scream.
25. It's too visionary.
26. You can't teach an old dog new tricks.
27. It's too radical a change.
28. It's beyond my responsibility.
29. It's not my job.
30. We don't have the time.
31. It will obsolete other procedures.
32. Customers won't buy it.
33. It's contrary to policy.
34. It will increase overhead.
35. The men will never buy it.
36. It's not our problem.
37. I don't like it.
38. You're right, but . . .
39. We're not ready for it.
40. It needs more thought.
41. Management won't accept it.
42. We can't take the chance.
43. We'd lose money on it.
44. It takes too long to pay out.
45. We're doing all right as it is.
46. It needs committee study.
47. Competition won't like it.
48. It needs sleeping on.
49. It won't work in this department.
50. It's impossible.

—From a list supplied by E. F. Borisch, Milwaukee Gear and AGMA president.

And the one sane answer: "Let's try it."

K. J. Langeman

Mass production for reinforced plastics—

FILAMENT-WINDING GROWS UP

After several successful years in the aircraft industry, this high-speed process offers new resins, fiber combinations, winding techniques—and is ready for more work. A primer on the method, its advantages and limitations.

H L DeBUSK, *senior mechanical engineer*
W R McCARTHY *senior structural engineer*
Brunswick-Balke-Collender Co
Marion, Va

Start with a spool of glass roving, run the thread through thermosetting resin, wind it tightly and uniformly around a steel mandrel to the thickness desired, cure it and remove the mandrel–and you've got a filament-wound, reinforced plastic structure.

This basic process–with plenty of mechanized refinements–is now producing ultraprecise radomes, pressure vessels and rocket casings. And current research on new resins and filaments, along with improved winding techniques, promises economies that will give even wider applications in fashioning reinforced plastic parts. Here's how the method works, its advantages and limitations, and some basic rules for design.

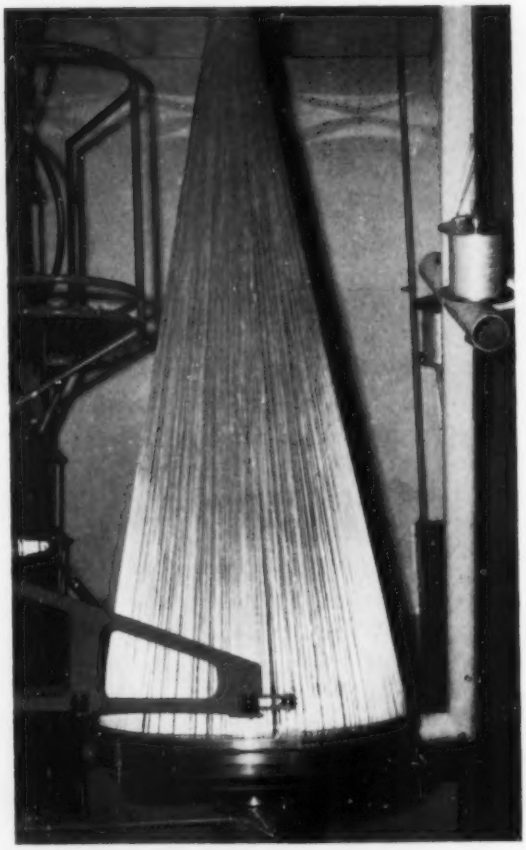
THESE ADVANTAGES

Higher rigidity is the key advantage of filament winding, as shown in the table on page 48. These gains in stiffness result from the unusually high glass-to-resin ratio achieved by winding a single, continuous filament under uniform tension over the mandrel. Modulus values approaching those of pure glasses are possible. Less deformation results, particularly under potential buckling loads. When applications call for electrical transparency–airborne radomes, for example–this stability of shape under load is highly important.

Greater strength of the filament-wound structures comes from absence of the fiber twisting and abrasion which accompany the weaving and handling of conventional cloth reinforcement. Because the single filament of glass does not have to be twisted under and over adjacent perpendicular strands, it provides a more uniform, symmetrical load-carrying member. Further, the designer can call for more fibers in the major stress direction–in amounts proportional to these stresses, for maximum loading efficiency.

Dimensional tolerances and stability are greatly im-

Step 1: *WINDING*



Impregnate, then wind it . . .
Here, with longitudinal fibers already in place, more of the thread is beginning its circumferential path over them. As mandrel turns, thread feeds from spool (upper right), through catalyzed-resin bath (not shown), and through guide pulleys (bottom). Machine winding gives precision placement, controls glass content to ± ½%.

proved because the part is wound and cured on a ground-steel mandrel, and finished by a closely controlled grinding operation while still on the mandrel. Production tolerances to 0.001 in. on thickness and 0.005 in. on over-all dimensions are consistently being held. On large radomes, for example, no electrical correction is needed once the final-ground electrical thickness is achieved.

AND THESE LIMITATIONS

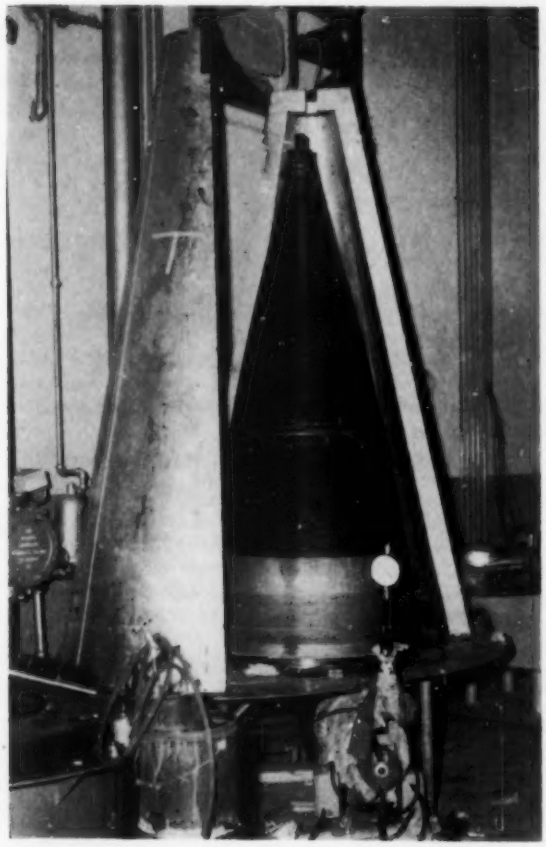
Interlaminar shear is the major structural weakness of filament-wound parts. Although absence of interweaving boosts tensile strength, it limits shear strength to the bonding given by the resin. In conventional cloth laminates, the high points of one layer tend to interlock with low points in adjacent layers—thus strengthening the composite against shear failure.

Lower ductility goes hand-in-hand with higher rigidity, so filament-wound structures have lower ultimate bearing strength than conventional laminates, and less ability to absorb stress concentrations around holes and cutouts. However, the original high tensile strength does allow adequate allowable design stresses to be selected.

Continuity of filament and low resin content give higher strength and modulus, but can also be major disadvantages when the finished part must be cut, drilled, or grooved for attachments or access openings. These steps tend to destroy continuity of reinforcement, and must be carefully performed because of the lower ductility. Cutting is a problem with cloth-reinforced plastics, too, but the problem is trickier with filament-wound parts.

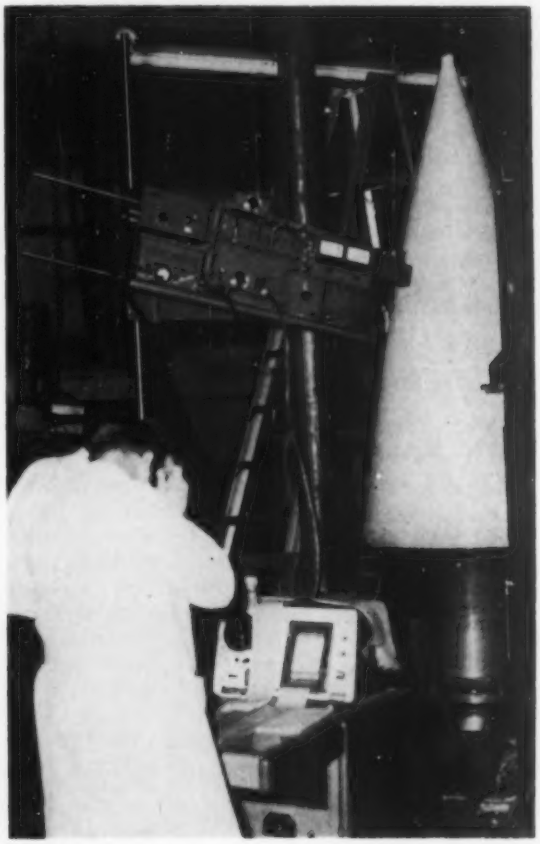
(CONTINUED, NEXT PAGE)

Step 2: *CURING*



Curing oven . . .
has same shape as the mandrel, which is now snugly covered by two layers of impregnated filament. Resin flowed together during the winding to form a homogeneous reinforced laminate, and now only requires curing for full strength. Resins most widely used are polyesters and epoxies, although new high-temperature phenolics and silicones are now available.

Step 3: *GRINDING*



Precision grinding . . .
is final step when parts require accurate electrical transparency and ultrasmooth outer surface. Inner surface already matches smooth surface of the mandrel. Electrical characteristics are checked closely with Insertion Phase Delay measurements given by one-horn interferometer. This keeps a close check on process, permits correction during manufacture.

Comparison of Reinforced Plastics

Property	Filament-wound (glass roving)	Hand lay-up (glass cloth)
Polyester resin, % by weight	10–25	30–40
Density, lb/cu in.	0.078	0.065
Ultimate tensile strength, psi x 1000	55–200	45–55
Tensile modulus, psi x 10^6	5–10	2–3.5
Ultimate compressive strength, psi x 1000	40–100	35–50
Compressive modulus, psi x 10^6	4–7	3–3.5
Ultimate flexural strength, psi x 1000	40–100	50–80
Flexural modulus, psi x 10^6	5–10	3–3.5
Interlaminar shear strength, psi x 1000	1–2	2–3
Bearing strength, psi x 1000	35–50	30–40

DESIGN FACTORS

The following basics will help pick those applications that unmistakably point to the filament-wound process despite its relative costliness. Included are some trends in winding technique and materials development that will bear watching.

Shape of parts must permit removal of the mandrel after curing and grinding, and reverse curvatures should be eliminated where possible. Since the filament is under tension, it is difficult to wind reverse curvatures. Present techniques permit some winding of reversed curves. New techniques, now under development, will permit winding more complex shapes. Two- or three-part mandrels and fusible mandrels have been used. New mandrel materials being used with the resins that cure at lower temperatures have greatly cut the cost of producing with fusible mandrels.

Cutouts and attachment holes can be reinforced by winding-in strips of conventional glass cloth, or specially prepared plastic or metal inserts. In most applications, such reinforcement has been found unnecessary. Present research is trying to improve interlaminar shear strength.

Resin materials used are essentially the same as those for conventional laminating processes. Polyester resins are cheapest and common, though somewhat restricted at present by the ever-increasing high-temperature requirements. Higher-temperature polyesters for filament winding are under intensive development. Epoxies are becoming more widely applied, too, and phenolics and silicones look promising for higher-temperature applications. Somewhat lower viscosities are specified for all resins used in this process–to permit flow during winding and prevent air entrapment. Radiant heat is occasionally used during winding to lower resin viscosity.

Among reinforcing materials, glass roving with commercial, bond-promoting finish is the cheapest and most common, and should be specified wherever possible. Development continues on newer filaments for higher temperatures. Materials being studied–by themselves and in combinations–include: glass, quartz, asbestos and ceramics. Some of these, when combined with the higher-temperature resins, have given filament-wound laminates stable to 2000 F.

Cost of filament-wound parts is low only with volume production, because the process is completely mechanized and requires extensive tooling to obtain the close tolerances of which the process is capable. Needed are a precision steel or cast-iron mandrel, a speed-controlled winder with careful tension control, a special curing oven, and a cam-controlled grinder. These features, developed after much experimentation, are what put fiber-reinforced plastic shapes into the mass-produced area. Since the process uses glass reinforcement in its cheapest form, it can offer cheaper production costs than with conventional laminating processes–once the original tooling has been amortized.

For REPRINT of above article, just check E95 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: For more about materials and processes for plastic laminates, check these articles:

"What's New About the New Papers?" Feb 16, '59, p 61—new treatments improve reinforcing-paper with better resistance to moisture, heat and flames—and new fibers add strength and dimensional stability.

"Selecting Plastic Laminates for Punching," Feb 2 '59, p 57—ready-reference chart relates punching ease of various laminates to their electrical and mechanical properties.

"Fiber-reinforced Plastics," Feb 3 '58, p 69—how 14 organizations have formed a team to set reliability standards for reinforced plastics. Five experiments cover 6 variables, with Graeco-Latin square analysis to make each test count.

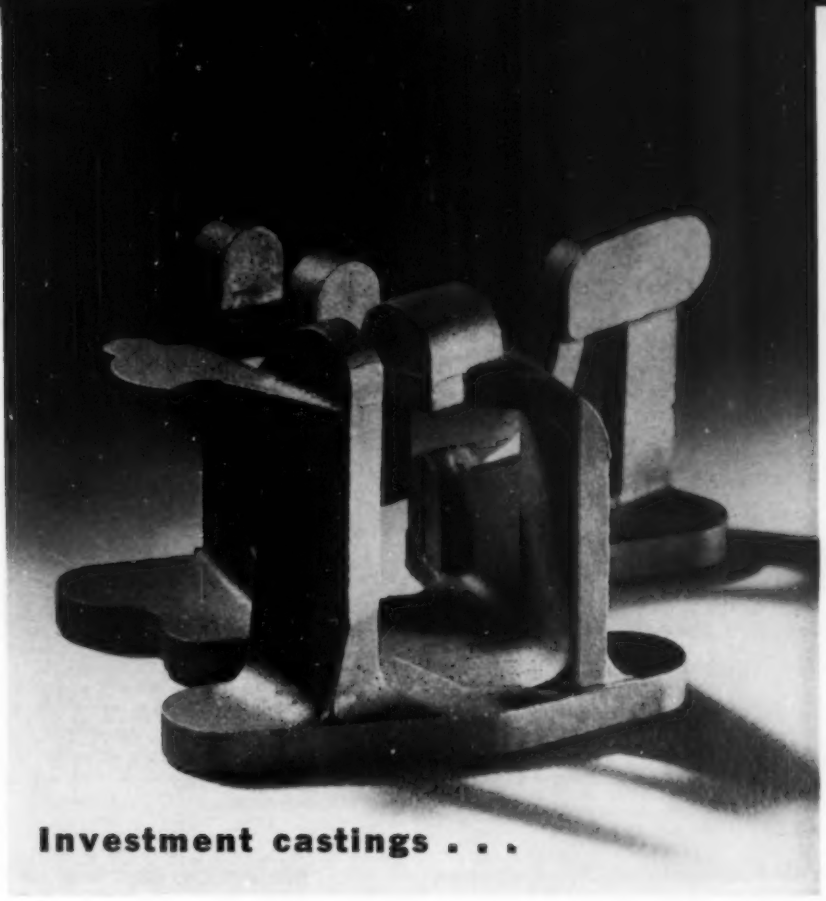
"Fiber-base Structure Materials," Feb '57, p 164—master selection table compares vulcanized fiber, phenolic laminates, fiberboard, rag insulation, polyester laminates, wood fiberboard, wallboard.

"Plastics for Structural Uses," June '56, p 167—staff report summarizes developments in materials and processes since World War II. Classified according to engineering jobs they help solve.

"Resins for Reinforced Plastics," May '56, p 135—compares 5 major classes . . . their processing characteristics, mechanical and electrical properties, appearance, cost, advantages and limitations.

"Creep of Reinforced Plastics," Mid-Oct '56, p C-22—8 fiber-resin combinations are compared up to 500 F.

"Plastic Springs," June '56, p 183—discusses methods of manufacture developed at National Bureau of Standards for glass-reinforced helical compression springs designed to operate at 135 F; how epoxy-glass springs perform.



TIGHT TOLERANCES CAN BE EVEN TIGHTER

Costs go down when the castings can be used "as is"—without need for any finishing steps. Here are ways to handle critical dimensions.

H MATTHIESON, *vice-president, process engineering*
Arwood Precision Casting Corp.

The investment casting pictured above is jam-packed with complexity, is only 3 in. long—yet is close to tolerance. Photos on next two pages show how design built tight dimensioning into this and other aircraft control fittings.

Ability to use such castings "as is" depends on thinking ahead. In general, investment casting allows tight tolerances. But usually there are one or two critical dimensions that need machining or grinding. It's when design holds them to specifications that any finishing steps can be eliminated.

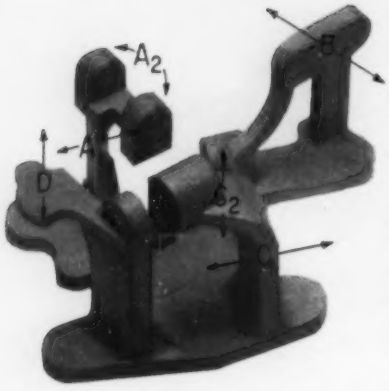
Tight tolerances begin with dimensioning on the blueprint. Surfaces that are perpendicular or concentric to others should be specified and the flatness requirements given. Good practice establishes basic casting planes in all three directions, with dimensions given to each plane. These reference planes will always be available for checking if they are picked up from unmachined flat surfaces or from the axes of holes or slots. Cast holes are particularly helpful in giving a better grip for straightening.

In general, ± 0.005 in. per in. gives a low-cost casting. Tolerances ± 0.003 or lower can be held if limited to one or two dimensions on small castings.

Flat surfaces should be given clearly defined limits, either by shape such as a boss, or by dimensioning. The larger the surface, the harder to hold flatness.

Cast shapes are usually heavy and rigid for compressive loads, but can be thinner when the stress is in tension. (Thin members, of course, should be loaded in pure tension to avoid flexure.) Rigid shapes can have closest as-cast tolerances—the distortion from casting is more predictable and can be compensated for in making the wax pattern.

Thin sections sometimes are needed for clearance or lighter weight. These sections, when uneven, tend to warp and distort during casting, so must be straightened. Depending upon shape, straightening can improve dimensional tolerances for thin parts and sometimes gives them



Four complex legs . . .
rise from flat base of the control fitting (photo, left). In casting they could come out warped—but design allows them to be straightened to restore tight tolerances. Arrows show possible directions of bending. Photos above (underside of same part) illustrate how better dimensions can also be had by temporary stiffening. Original ¼-in. round gates, left, were joined (right) by continuous rib. Both are later removed.

tolerances closer than rigid parts—but such shapes must be designed specifically for straightening.

For example, a round cross-section can warp in any direction—and in a long piece, may warp in several. Changing to an oval gives more rigidity across the major diameter, but still does not fix direction of warpage. A square would limit movement to two directions and a thin rectangle of same area would allow movement in one direction only. While such design might exaggerate warpage in that direction, it allows easier straightening. Box shapes, which give maximum rigidity, cannot be cold-formed; any discrepancy in dimensions must be corrected by adding stock, then machining.

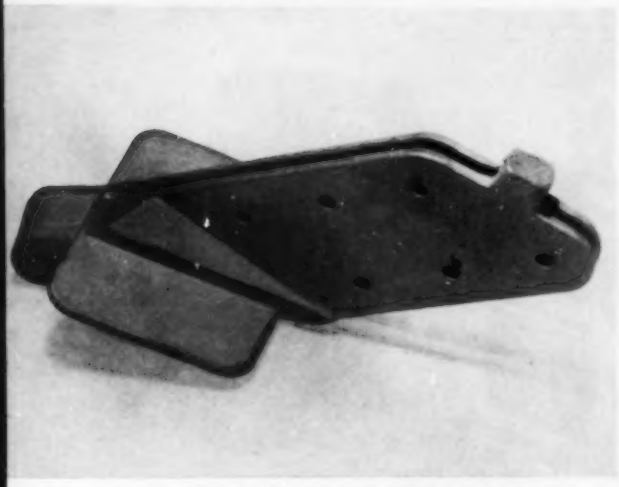
Materials are rated in the table at right for ease of straightening. Because cost for this step is 5 to 15% the cost of the entire part (often more than cost of the basic materials), it may pay to choose a more costly material if it is easier to straighten. Ductility, when choosing the material, is the main consideration; it allows high plastic deformation for straightening. In general, materials with high yield strengths (above 75,000 psi) lack enough ductility to deform without cracking.

Coining and pressing by hydraulic presses in a fixture, or twisting by levers, can make linear dimensions straighter, surfaces still flatter, or can bend a segment slightly to bring it within given tolerances. Usually the extent of straightening is no more than a few thousandths of an inch linearly or 1 to 2° angularly. A variation of straightening is the cold-working procedure that can improve roundness of the ID of a hole by pushing a sized mandrel through it. Similarly, the OD can be made rounder by pushing the part through a die. Eccentricity of tubes usually cannot be corrected except by the amount caused by any irregularities of the ID and OD.

Investment-cast Alloys Rated for Straightening

Ease of Straightening	Alloy	Mechanical-property Requirements UTS, psi	YS, psi	ELONG., % in 1 in.
GOOD	1020	60,000	30,000	24
	1045	80,000	40,000	16
	3120	70,000	40,000	20
	8620	70,000	40,000	20
	302	70,000	30,000	35
	303	70,000	30,000	30
	304	70,000	30,000	35
	310	70,000	30,000	30
	316	70,000	30,000	35
	347	70,000	30,000	30
	420	110,000	67,000	18
FAIR	4130	150,000	125,000	9
	4140	140,000	110,000	8
	410	95,000	75,000	8
DIFFICULT	416	95,000	50,000	6
	17–4ph	180,000	150,000	6
	410	140,000	110,000	5
	431	170,000	130,000	4
IMPRACTICAL	4340	175,000	160,000	3
	410	180,000	150,000	3
	6150	190,000	175,000	2
	52100	190,000	180,000	2
	440A	100,000	80,000	2
	440C	110,000	80,000	2
	440F	110,000	80,000	2

ON COMPLEX PARTS



The need for parallelism . . .
between two plates is met by casting with a connecting lug, which is later removed. Costs for the added material needed for stiffening are minor in investment casting, compared with over-all processing costs.

Rigidity and flexibility . . .
go together in this casting, comprised of base and pair of thin, complex "tines." Here, stiffening for dimensional control—channel section and gusset—is retained in finished part. Tines are aligned by straightening.

Straightening Allows These Tighter Tolerances

Linearity

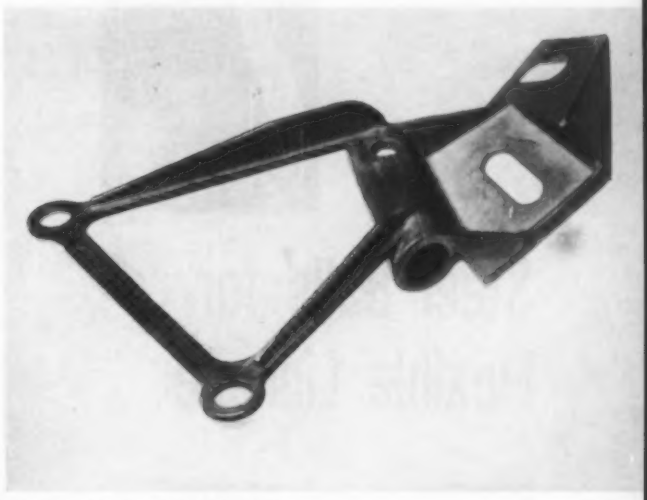
length, in.	tolerance, in.	
	as-cast	straightened
under 2	±0.010	±0.005
2–4	±0.015	±0.010
4–6	±0.020	±0.010
over 6	±0.030	±0.015

Flatness

length, in.	tolerance, in.	
	as-cast	straightened
1	±0.008	±0.004
2	±0.016	±0.006
4	±0.025	±0.010
6	±0.030	±0.015

Parallelism

distance between parallel surfaces, in.	tolerance, in.	
	as-cast	straightened
1/16	±0.003	±0.003
1/4	±0.003	±0.003
1/2	±0 005	±0.004
3/4	±0 006	±0.004
1	±0.007	±0 005
1 1/2	±0.010	±0.007



Don't rely on straightening . . .
to restore tolerances for a twisted-shape part like this. To keep alignment of the three basic planes, it is given rigidity that cannot be removed—reinforcement with the ribs and gussets.

EDITOR'S NOTE: For more on investment casting of small intricate shapes:

Powdered Glass Gives Mold for Stronger Castings, Oct 14 '57, p 68, discusses investment castings in terms of ceramic shells that give fine grain for better strength and ductility.

Design for Investment Casting, Apr '56, p 166, gives advantages and limitations of this method; lists alloys available.

Evaluation of Casting Processes, Mar '54, p 139, compares the six basic methods of casting for their complexity of shape, dimensional tolerances, applications and cost.

Design objectives . . .
for new Graphic (at right) were improved appearance, reduced weight, increased strength and durability—as well as bringing numerous standard attachments together in a single unit. For materials the choice was narrowed to aluminum and magnesium. Camera body is aluminum extrusion cut to length, formed and butt-welded. Its edge beads increase strength and act as anchoring bosses for components and accessories.

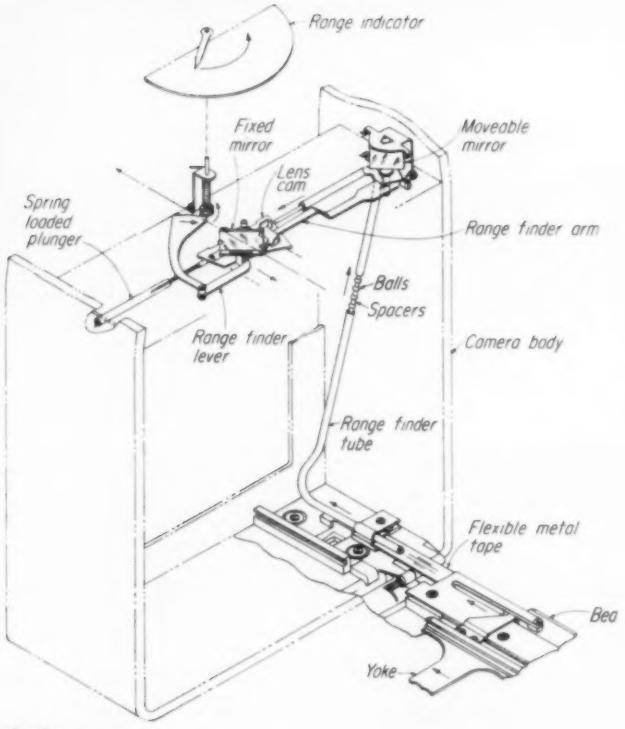
Magnesium castings are used for the front bed and the two-piece revolving back. The front bed uses nylon yoke guides, one of them spring-loaded to eliminate play and prevent lens movement.

Top compartment of the camera measures only ¾ x 6¼ x 2½ in., yet contains two 22½-v batteries, rangefinder mechanism, focusing-scale drive, two 80-mfd capacitors and the shutter-release switch. Miniaturization of components and use of printed circuits provide key to economical use of space.

Steel Balls for Flexible Linkage

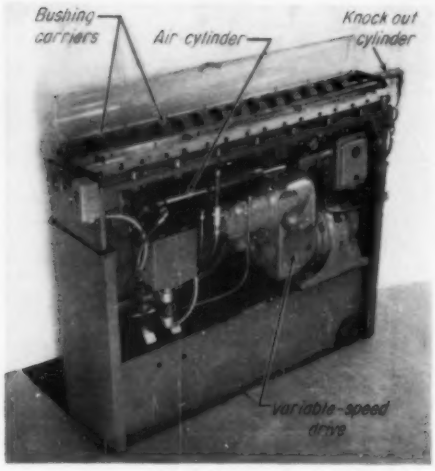
Latest model of this famed press camera uses continuous metal linkage to transmit camera lens position to optical rangefinder and distance indicator. Aluminum body is lighter and eliminates moisture absorption.

Older models of the camera had "grown like Topsy" over the years as modifications and accessories were added. As a result the cameras were studded with attachments and protuberances. Industrial designer Peter Muller-Munk redesigned camera to incorporate all functions and achieve an integrated design. Super Graphic is produced by Graflex Inc, Rochester, NY.



Rangefinder . . .
is enclosed in upper part of camera body. Because of redesigned front bed and body linkage, the rangefinder actuator was changed from a plunger to a continuous metal linkage. A chrome-plated, spring-steel tape with a fixed radius, similar to metal measuring tape, is attached to the yoke and bridges the hinged bed joint. A 3-bend tube from rangefinder has a plunger at lower end, which is pinned to the metal tape. Tube is filled alternately with steel balls and cylindrical spacers to transmit changes in focusing-track position to rangefinder.

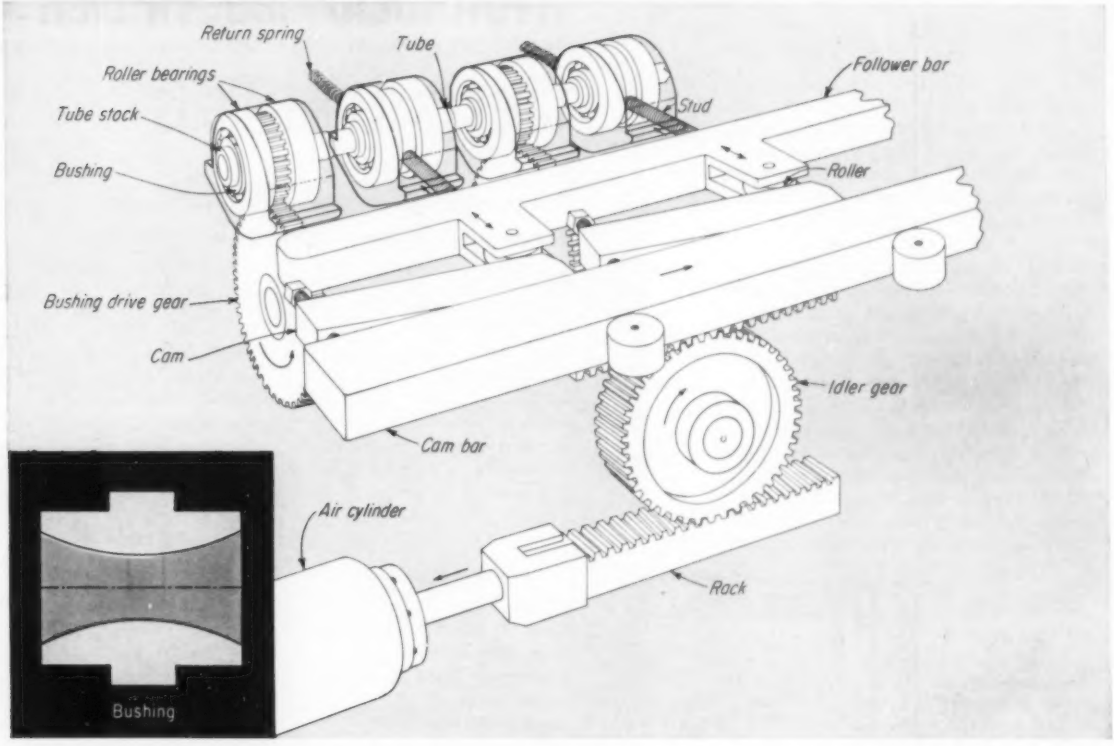
A metal cam moved by a plunger at upper end of tube actuates the movable mirror and range indicator through the rangefinder arm. Different cams are used for varying focal-length lenses.



Straightens Odd Shapes

Stepped, tapered or oddly cross-sectioned tubes or rods are straightened in less than 30 sec by unskilled operator with this machine. Additional passes or longer cycle reduce runout if desired.

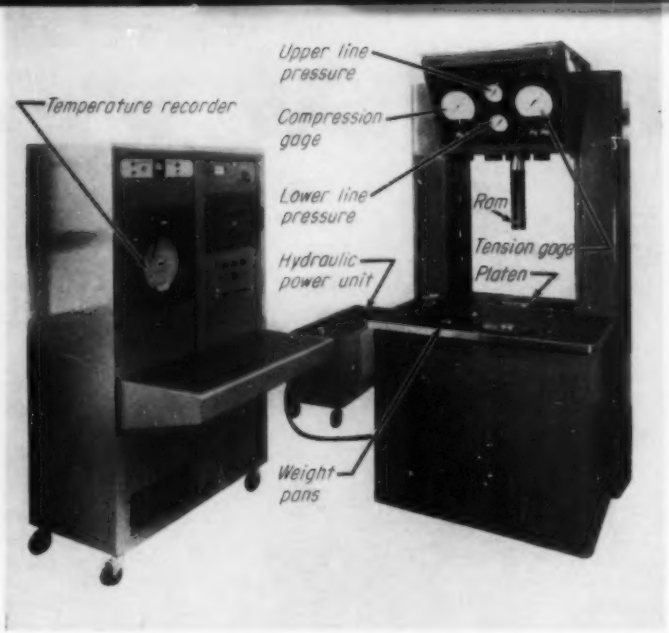
Produced to straighten stepped golf shafts, machine replaces hand operation that required skilled operator and took 4 to 5 times as long. Simple bushing arrangement permits rapid conversion of straightener to handle tubes or rods of different diameter or cross-section. Produced by Special Machinery Co, Winsted, Conn.



Tube stock to be straightened . . . is inserted in left end of machine. Bearing-mounted bushings correspond to shape of the stock. Operator pushes button and machine goes through complete cycle, automatically ejecting straightened tube. Stepped golf shaft shown being straightened has 15 different diameters, is chrome-moly steel 0.014 in. thick. After straightening, runout in 46-in. shaft is less than 0.020 in. in one pass, and can be reduced to 0.005-in. runout by second pass.

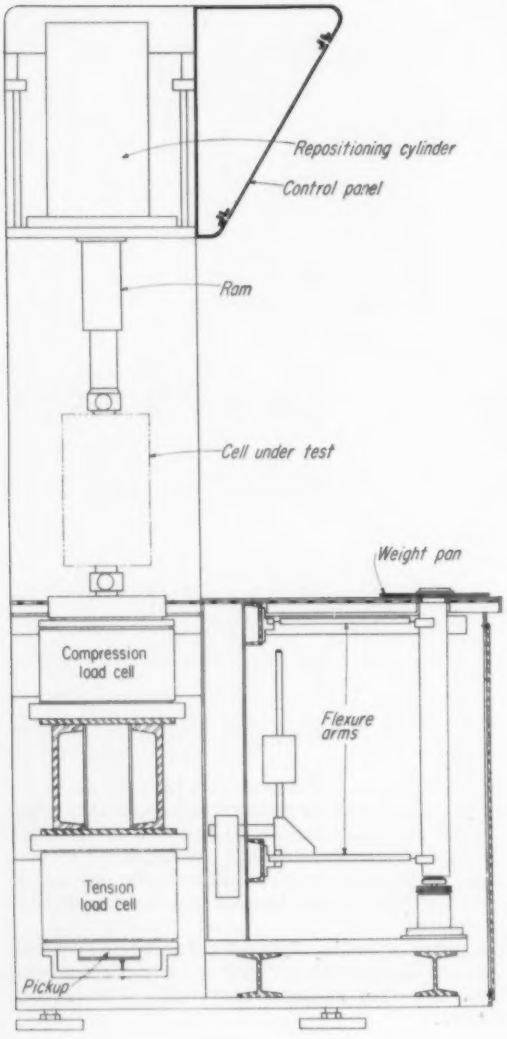
When operator pushes button, air-oil cylinder rod retracts and drive motor starts. Rack attached to cylinder connecting rod rotates idler gear and drives the cam bar and cams to the right. The cams move alternate roller-bearing bushings back out of line with the geared driven bushings and hold this position as the rod is slowly rotated. At completion of cycle, the air-oil cylinder is reversed, cams move to the left, and the return springs push the idler bushings back into line with the driven bushings.

Cross-section of bushing shows internal curvature to prevent crushing or kinking of thin wall tubing. Radius of curvature is slightly less than minimum bend radius of tube being straightened.



Complete test setup . . .

consists of three units: load-cell tester, console with readout equipment, and hydraulic power plant. Tester has vertical opening of 30 in. and piston rod is threaded to mount load cells for tension or compression testing. Console contains instrumentation to check load-cell output, also a recording thermometer to monitor ambient conditions for correction factors. Hydraulic power unit delivers 1 gpm at 2500 psi, contains air-cooled hydraulic fluid heat-exchanger, and an accumulator that protects the system from surges.



HYDRAULIC MULTIPLIER Checks Load Cells

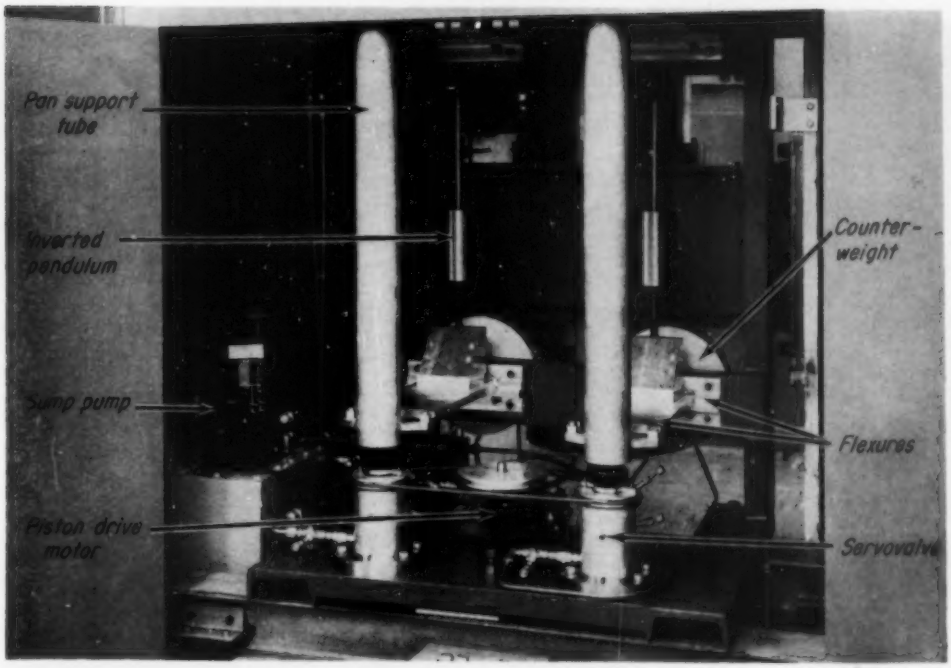
The rotating pistons, inverted-pendulum balance and flexure pivot system combine to eliminate errors that would be magnified 450 times. Roller-pin drive for pistons provides frictionless slip joint.

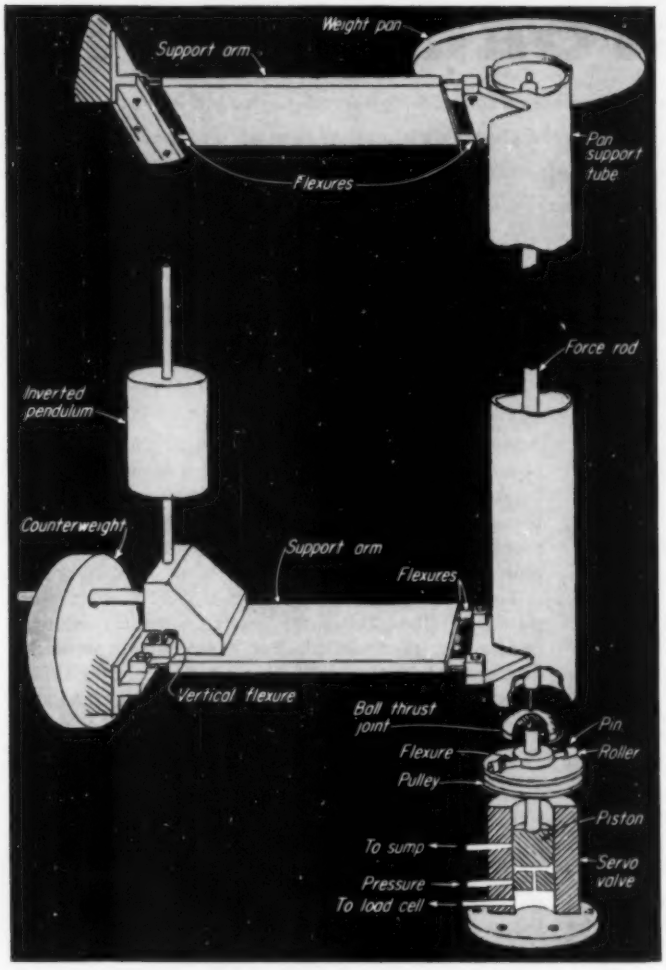
Hydraulically operated load-cell calibrator has a capacity of 25,000 to 100,000 lb in either tension or compression. Total accuracy of applied load in the system calibrations (including linearity, repeatability and hysteresis) is within ±0.05% of reading down to 20% of full scale and ±0.01% of full scale below 20% of range when operated in an ambient temperature of 70 ± 5°F. Mark IV Load Cell tester is produced by Statham Instruments Inc, Los Angeles.

During test operations . . .

calibrated weights placed on the weight pan force it downward and cause the servovalve connected to it to admit oil into the load cell. Movement of the diaphragm-sealed load cell displaces a differential transformer linked to it. The differential transformer, responding to movements as small as 0.0005 in., produces an electric output signal proportional to the displacement. This is multiplied by a servo amplifier which supplies a proportional output to the hydraulic repositioning cylinder. The force exerted by the repositioning cylinder is applied to the cell under test until the output transformer is returned to the null position. By returning the load cell to a constant position automatically, the nonlinearity inherent in diaphragm systems is eliminated.

Once the system is returned to its original position, the operator can log the calibration from the readout system. Load-indicating gages are extremely accurate but system accuracy is dependent on the accuracy of the test weights used and the accuracy of the force multiplication system. Weights are supplied in 10 equal increments to full test load and are accurate to ± 0.005% of increment.

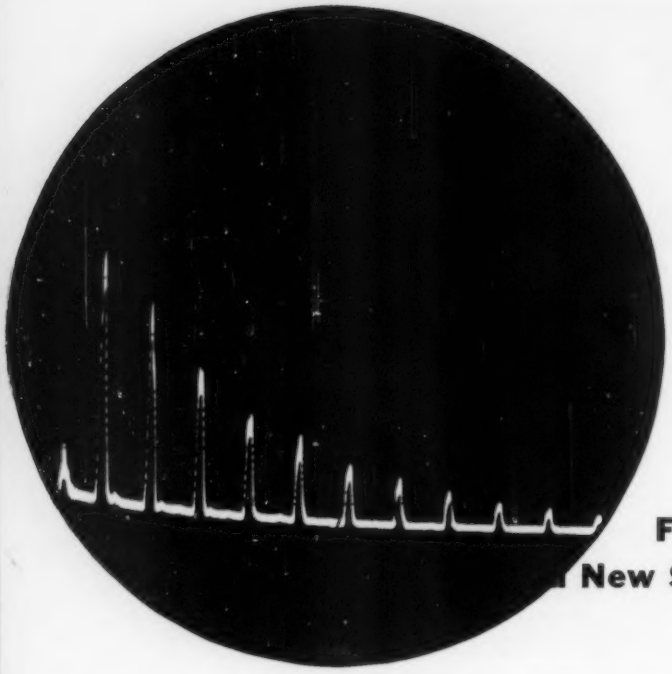




Lap-fitted pistons . . .

are supported by oil pressure beneath them and rotated by an electric motor to eliminate hysteresis and friction. Weight of connecting rod support-arms and pan-support tube are balanced by a dual counterbalance system. Inverted-pendulum balance weights permit adjusting the moments of force to eliminate natural frequencies that might be amplified by the hydraulic system and prevent it from reaching equilibrium. Vertical flexture on lower support arm prevents combined load of counterbalance and inverted pendulum from distorting the horizontal flexure. Ball-bearing thrust joint allows piston to rotate freely while force rod is stationary.

Support-arms keep pan-support tube vertical and weight pan horizontal when test weight is applied to weight pan. Cylindrical flexures at ends of force rod prevent transmission of side loads to servovalve piston. Flexures and rollers on piston drive permit vertical movement of piston and prevent side forces, which might result from misalignment, from being transmitted to piston.



From Ultrasonics
New Stress-analysis Technique . . .

ACOUSTOELASTICITY

These two researchers polarized high-frequency sound waves and made them do anything the photoelastic methods can do, and something more—check for residual stresses. Here's their first published account of how the method works, and of still newer developments now underway.

Dr R W BENSON, *assistant director, physics research*

V J RAELSON, *associate physicist,*

Armour Research Foundation

Ultrasonics has provided a new way to analyze stresses in a structure or machine part. Christened the "acoustoelastic" method, it puts polarized sound waves to work in much the same way that the photoelastic method employs polarized light waves–but with these important advantages:

• There is no need to build a plastic model of the part being analyzed. The opaque nature of the part does not hinder analysis–as it does when light waves are the measuring tool.

• Residual stresses in a machine part, whether from the manufacturing process (machining, forming, casting) or from assembling, can be quickly determined. The part is not affected, making this the first successful nondestructive method for analyzing such stresses. (Photoelastic method cannot check for residual stresses because it is confined to models. Other techniques such as stress coating, PhotoStress, or strain gages use the status of the part as is, and go on to compare it with status of the part under load.)

• Magnitude of the stresses can be evaluated directly–no computations needed to determine a datum line, as with the photoelastic method.

• Equipment can be made portable for field testing. Structures such as planes, bridges, railroad tracks can be scanned for the possibility of high, localized residual stresses unknown to the designers. Equipment for laboratory testing is relatively simple and inexpensive.

• Method handles almost any type of material–metal or nonmetal. The only requirement: a sound wave must be able to penetrate it. Best results come with materials that least absorb sound, such as the metals. And shorter sound waves are more efficient–hence the use of ultrasonic frequencies.

The acoustoelastic method does not yet produce visual pictures of the stresses–readings are obtained from an oscilloscope, then plotted. But improvements are under development which indicate it will not be too long before the distribution of stresses can be shown directly on a viewer.

Acoustoelasticity–the Technique

The new technique is based on the premise that there exists a stress-acoustic effect similar to the familiar stress-optic effect. In the optical case, a stress inside an optically transparent object will change the index of refraction–and thus change the velocity of light. When a polarized light beam is passed through that object, the different components of light traveling along

Birth of a New Method

Do stresses in a medium affect the speed of sound waves, and how?

This has been a fairly old, and puzzling, question to physicists. Though some investigation was made, there were no definite conclusions.

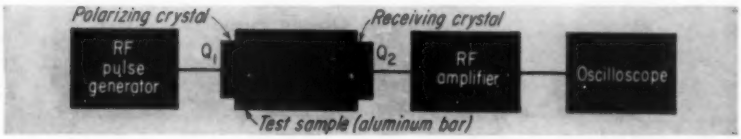
Accordingly, the authors requested and obtained funds from Armour Research Foundation for research in this field—even though projects at Armour are usually requested and sponsored by outside sources.

Answer to the question came within a short time:

Subjecting a part to compressive loads increases the speed of sound passing through it—but so slightly that only extremely delicate instruments would be able to indicate magnitude of the loads (or stresses) that caused the speed change.

The authors then turned to the photoelastic method of stress analysis, guessing it might point the way to an analagous technique utilizing ultrasonic waves. The missing link between the two, a way to polarize sound waves, was provided by a Y-cut quartz crystal transducer. Fed by a pulse generator, it creates acoustic waves in a solid which vibrate in a direction transverse to direction of sound propagation. These are called shear waves, and by analogy with light can be considered polarized.

The authors used a similarly cut crystal to pick up the signals on the other side of the specimen. Then, using an oscilloscope (as shown in accompanying photo—Dr Benson at right), they confirmed that polarized waves will rotate when passing through a material under stress, and that there is a direct relationship between degree of rotation and magnitude of the stress.



Equipment Required . . . is relatively simple and inexpensive. One can get by with just a pulse generator, two quartz crystals, an amplifier and an oscilloscope.

the axes of principle stress will have different velocities and will cause a rotation of the angle of polarization of the light beam. If this angle is chosen judiciously with respect to the axes of principle stress, it will vary, indicating the stress distributions within the optically transparent object.

The acoustoelastic method produces a similar effect by emitting polarized ultrasonic waves and detecting the change in angle of polarization after these transverse waves pass through the part under stress. The waves are generated by a radio frequency pulse generator coupled to a Y-cut quartz crystal. The crystal is mounted against the test sample with wax, and another such crystal is mounted at the output end of the sample. Signals passing through the sample are then amplified, and displayed on an oscilloscope.

Signals are sent out in short bursts rather than in a steady stream. This allows for discrimination against standing waves which may set up within the object, and also allows confirmation that the energy is in the form of ultrasonic shear waves. This is possible because in most metals the velocity for shear waves is approximately one-half that for the usual compressional waves.

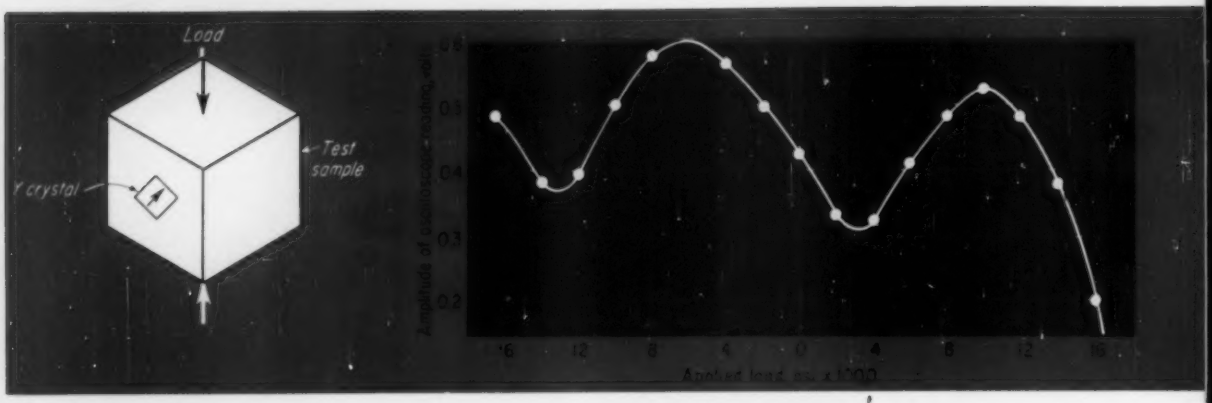
The input and output crystals are lined up so their preferred direction of vibration is identical, and the signal on the oscilloscope screen shows maximum amplitude. If either crystal is rotated with respect to the other, a decrease in signal will be observed which is a function of the cosine of the angle between the preferred directions of vibration of the two crystals. This is similar to the use of polaroid analyzers in the optical case.

If the crystals were oriented so that angle of polarization lay along the major axis of stress as caused by an externally applied load, there would only be a change in the absolute velocity of the signal. Such a measurement, moreover, is rather insensitive—for reasonable stresses the velocity would change by less than 1%. For this reason both crystals are oriented at 45° with respect to the principle axes of stress.

The polarized sound wave can now be considered to consist of two components—one along each of the two axes of principle stress. An external load to the sample creates different stresses along the principal axes and, because the velocity of sound is a function of the stress within the object, the velocity of the two components will be different. A signal arriving at the receiving crystal will change because of an apparent shift in the angle of polarization.

Test Procedure

First studied was an aluminum bar 5 in. long, 1 in. square. Signals generated were determined to be shear



Crystals mounted . . .
at 45° with respect to load.

Amplitude of response . . .
of receiving crystal against applied load.

waves by a measurement of the transit time for an ultrasonic pulse through the bar, which allows for a determination of velocity.

An external force was now applied to the aluminum bar and the amplitude of the received signal was measured as a function of the magnitude of the force. A second series of measurements was also made—here load was applied to opposite faces of the aluminum bar. The resulting information was plotted as shown in the above chart, to indicate amplitude of the received signal vs the applied load. Maximum pressure applied was 16,000 psi. In the chart, readings to the right of origin indicate a load applied to two surfaces of the bar; readings to the left indicate the load applied to the opposite two sides of the bar.

The received signal varies with applied load, revealing a stress acoustic effect. The frequency used was approximately 7 megacycles/sec and the observed results indicate a sensitivity sufficient (loads of 100 psi were detected) for the measurement of stress. An increase in frequency will allow for more variation with applied load since the angle of polarization will rotate through more degrees with increasing frequency.

Thus, sensitivity of the method depends on frequency employed and the path length of the sound wave. In fact, the number of degrees that the polarization angle rotates is directly proportional to path length and to frequency. It is, of course, expected that for different materials the stress acoustic effect will vary.

Detection of Residual Stresses

The sending and receiving crystals were so oriented in the foregoing test that their preferred direction of vibration was in the same direction. This would indicate that the condition of no stress would give a maximum signal. But the chart shows that, instead of the maximum occurring when no external load is applied (zero gauge readings), two maxima occur—one at 6000 psi (at left of zero) and the second at 10,000 psi (to the right).

Either maximum, or perhaps even still another existing to the left or right (at higher loads), could be the maximum representing no change in velocity with respect to a stress-free condition. It appears as if it was necessary to apply an external load to produce a condition of no stress. In other words, the technique has revealed a residual stress within the material.

If the frequency is changed, the only maximum which will not shift is that of a true zero-stress condition. Therefore, the frequency was lowered and it was found that the peak to the left of origin corresponded to the no-stress condition. This indicates that a residual stress of approximately 6000 psi was present. To measure this value with more accuracy, the frequency was again increased.

How to Obtain Pinpoint Analysis

The above measurements gave net change in angle of polarization over the entire length of the acoustical path and the entire cross-sectional area of the receiving crystal. The crystals covered the central portion of the aluminum bar and were approximately ¾ in. square.

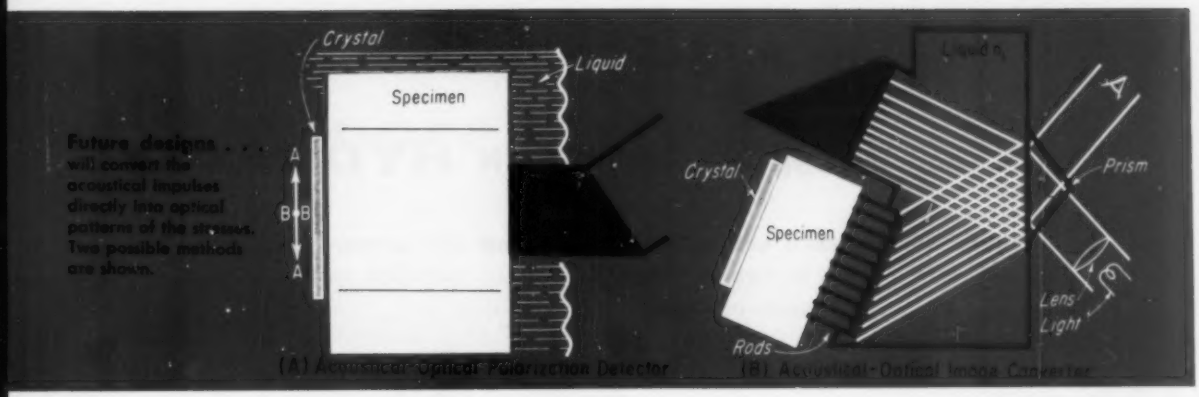
In practice, however, it is highly desirable to determine variations in the stress pattern from point to point over the cross-section of the sample. This is what is obtained, for example, in using the photoelastic technique.

Simplest method with the acoustoelastic technique is to use a group of small crystal probes similar to a mosaic. Practical probes can be constructed which are about ⅛-in. square and have sufficient sensitivity to make the measurement. At these ultrasonic frequencies, the sound wave is well collimated so that within the limitations of diffraction effects, stress patterns may be revealed.

Another technique uses a larger pair of crystals and applies a movable electrical probe to the back of the receiving crystal. Although these crystals are usually silvered on both sides for collecting the total charge, it is possible to operate with the back side of the crystal unsilvered and to collect the charge with a suitable probe.

Because quartz is a good insulator, the charge distribution remains unaffected with the exception of that surface covered by the probe. A mechanical scan of the back surface of the crystal with the probe will therefore reveal the stress pattern. This technique has been utilized successfully in the authors' laboratory, although it is relatively slow.

Similar probing of the crystal can be obtained with electron beam scanning similar to that done by the television pickup tube. Variations of such a device are being



developed in both this country and abroad, and feasibility has been demonstrated.

Acoustic "Pictures" Are Possible

It is desirable, of course, to directly convert the acoustical signals to optical energy. Two possible methods are illustrated above. The method shown in (A) employs a Y-cut crystal to generate transverse acoustic waves, and an acoustically transparent rod, flat on one end and beveled on the other, to detect the angle of polarization. If the beveled end of the rod is submerged in a liquid, there will be a transfer of energy from the rod to liquid only when a component of the particle motion of the beveled surface, caused by the sound wave, is normal to the surface.

As the angle of polarization varies, a change in the amount of energy transferred will be observed. In addition, the presence of a sound wave within a liquid produces a change in the index of refraction for light waves. This change in index can be observed by several means. For instance, an optical Schlieren system has been used to observe ultrasonic waves.

Direct observation of the stress pattern on the face of the specimen is also possible, with the method in (B). If the rods are short enough to be considered stress-free, then the angle of polarization at the exit end of the object also exists at the beveled ends of the rods. Amount of energy transferred to the liquid from each rod will depend upon angle of polarization at other end of that rod. The energy transmitted into the liquid will be refracted toward the other side of the tank and then be reflected toward the absorbing material in the tank. By these means, standing waves can be avoided.

At the other side of the tank is an optical prism suitably designed as to proper angles and index of refraction for light relative to the liquid. If there is no sound energy at the prism face within the tank, then light entering the prism from the lens normal to the sloping side of the prism will be totally reflected at the base face of the prism. This is because the index of refraction of the glass and the angles of the prism have been so chosen that the light is incident at an angle slightly larger than the critical angle of incidence at the glass-liquid interface.

If, on the other hand, sound energy is in the liquid at the glass-liquid interface, the index of refraction of the liquid is changed. As a result the angle of incidence of the light on this interface is no longer larger than the critical angle of incidence and some light is refracted into the tank. This would result in a decrease in intensity of the light reflected from the interface.

In this way, any variation in the intensity of the sound beam incident upon the liquid-glass interface is reproduced as a variation in light intensity of the light beam emerging from the exit face of the prism. Thus the stress variation over a cross-section of the sample can be converted into an optical image of that variation.

How Acoustoelastic Constants Can Help

Constants will undoubtedly be developed in the near future which relate stress directly with the degree of rotation of the polarized sound waves. This would speed up the test procedure. The constants will involve five factors; for example:

Material	Test Frequency	Path Length	Pressure	Degree of Rotation
Material A	1 megacycle	1 in.	1000 psi	5°
Material B	1 megacycle	1 in.	1000 psi	16°

Let's see how the constants can be put to work. A signal sent through a sample which is not under load, and has no built-in residual stresses, will produce the typical oscilloscope pattern above.

Only the magnitude of the first peak, distance x, need be studied; pulses that follow are caused by the signal reflected back and forth through the sample.

Next, the sample is subjected to the test load. This reduces the first peak to distance x_1. Degree of phase rotation is equal to the cosine of the ratio x_1/x. Thus, if $x = 4.6$ volts and $x_1 = 2.3$ volts, it indicates that the polarized waves have rotated 60° ($\cos 60° = 0.5$). If the test frequency was 1 megacycle, and the part was made of 1-in. thick material A, the 60° rotation indicates a $(60/5)1000 = 12{,}000$ psi stress in the path of the signal.

For REPRINT of above article, just check E94 on one of the Reader Service cards bound in this issue.

PRESSURE LOSSES IN HYDRAULIC

These performance curves for flush, elbow and probe-type takeoffs relate losses to branch-to-main velocity ratio, branch-off angle and design.

C M DANIELS, *supervisor*
H A PELTON, *research engineer*
Rocketdyne Div, North American Aviation

When a hydraulic line branches off into complicated takeoffs, the data on pressure losses become more complex too. Design then needs more than the usual information based on standard fittings. In this case the accompanying pressure-loss charts will help. Besides supplying working curves, they sketch important branch-type fittings in terms of the flow paths through them—usually so difficult to evaluate.

The curves are plotted as wide lines to emphasize that data are only approximate. Yet curves can be definitely useful within the limits described below, and good correlation can be expected. To insure consistency, these data from Rocketdyne were cross-checked with results from similar studies made in Germany.

All of the curves are based on tests of fittings with branch diameters varying from 1 to 1.7 in., and main-pipe diameters from 1.7 to 3.8 in. Fittings out of this size range will have pressure-loss characteristics that follow the same trends; but special tests–using the actual piping where possible–are recommended.

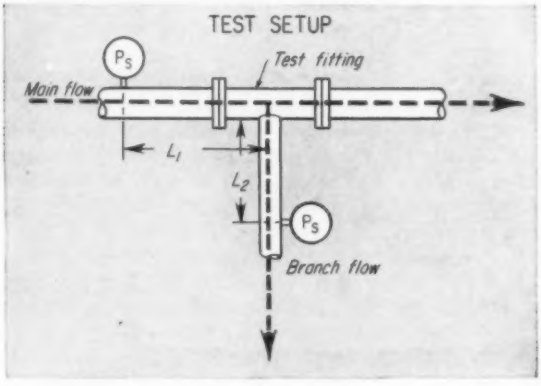
For fittings within the range tested, these rules apply:

- If the branch has a small diameter compared with the main pipe (ratio about 1:3), then read pressure loss coefficient from upper edge of each curve.
- If the branch is relatively large (about 1:1) read pressure-loss coefficient from the curve's lower edge.

The effect of the diameter ratio can be seen in this example: For a typical 60°-angle flush takeoff, when branch-to-main velocity ratio is held at about 1, reducing the branch-to-main diameter ratio from 1:1 to 1:3 increases the value of K by about 25%. Such a small difference can be ignored in many piping calculations, because approximations made elsewhere in the circuit will be far less dependable.

Nomenclature

K = Pressure-loss coefficient in branch, $\Delta P_T/(P_V)_{MAIN}$
ΔP_T = Total-pressure loss through branch, lb/sq ft:
$\Delta P_T = (P_S + P_V - \Delta P_{L1})_{MAIN} - (P_S + P_V + \Delta P_{L1})_{BRANCH}$
P_S = Static pressure, lb/sq ft
P_V = Bulk-velocity pressure, $\rho V^2/2g$, lb/sq ft
V = Bulk (average) velocity, ft/sec, calculated from volume flow and pipe area
ΔP_L = Pipe friction loss, lb/sq ft, calculated with Darcy equation
ρ = Density, lb/cu ft (62.4 for water)
R_N = Reynold's number $\rho DV/\mu$, where symbols are fluid density, pipe dia, fluid velocity and viscosity in consistent units

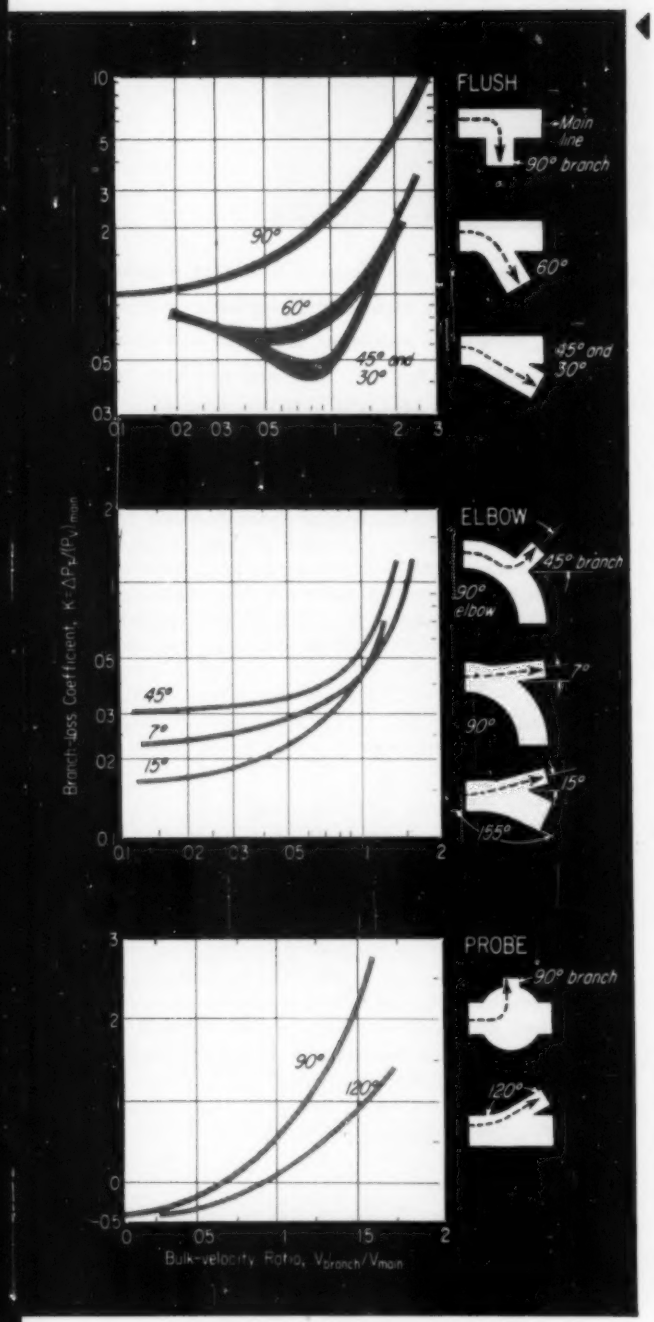


Configuration Important

Elbow and probe-type takeoffs give lowest branch losses because velocity of main stream is directed into branch inlet, contributing energy that is converted into pressure. The loss curves for probe-type pickups under certain conditions even show negative pressure drops, but this is a fallacy and has an explanation: The computing method assumes an "average" velocity for all points in any flow cross-section, yet the probe actually senses a much higher velocity (near the pipe center) than the average "bulk" velocity, and more energy is available.

Flush branches show highest losses, and these increase with the takeoff angle. Losses in 90° flush takeoffs can be significantly reduced by widening the branch entrance to give funnel shape–(this was not done in the tests plotted here).

BRANCH-OFF FITTINGS



Tests Show Pressure Losses in 3 Types of Takeoff (*K* values are appropoximate. Tests used water but curves apply to oil and other liquids.)

Most configurations of flush, elbow and probe branches have pressure-loss coefficients that increase with velocity ratio. This is probably because the effective area at the branch entrance decreases with an increase in branch flow. The effect is similar to the contraction in flow area when a large stationary body of fluid discharges into a pipe—the fluid is accelerated axially, but part of the fluid must enter radially. Exceptions are flush fittings with takeoff angles of 45° or less; for them, the *K* value seems to decrease somewhat with velocity-ratio rise for low ratios up to about 0.8. Probe-type branches show a relatively small amount of contraction of area, because branch-to-main velocity ratio must exceed 1 before radial inflow occurs.

Mainline pressure losses are not plotted here but may increase if the branch obstructs flow. Probe-type branches cause greatest losses because the probe is directly in stream. Flush-type branches do not increase mainline losses. Branches in elbows have no direct effect on mainline losses, but the elbow itself adds a normal amount of pressure drop.

What About Reynold's Number?

Except for velocity ratios greater than 1 or 1.5, Reynold's number, R_N, has little effect on the values for pressure-loss coefficient *K*. In these tests R_N was varied by changing flow rates through the branches . . . and velocity ratio was held constant.

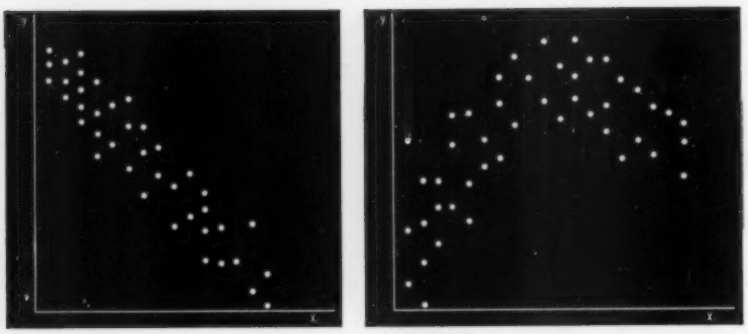
Tests of 90°-takeoff flush fittings at R_N values from 600,000 to 2,000,000 showed no effect on *K* for branch-to-main velocity ratios less than 1.0. At higher ratios, however, effect is quite pronounced. For example, at a ratio of 1.5, *K* increased from 3 to over 4 when R_N changed from 600,000 to 2,000,000. Tests of 120°-probe fittings indicate Reynold's number has no effect below a velocity ratio of 1.5. At a constant-velocity ratio of 2, however, *K* increases from 1.8 to 2.1 for an R_N increase from 1,000,000 to 2,700,000.

For REPRINT of above article, just check E93 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: A previous article by the same author, "Pressure Losses in Flexible Metal Tubing," Apr '56, p 223, tabulates friction coefficients for concentric and helical corrugated tubing, and gives nomographs of pressure drop.

REGRESSION ANALYSIS

digs out equations from scattered data



When data looks like this . . . . . or this

How can you draw a line that accurately represents relationship between x and y? Here's the statistical tool that will give an equation for that line—and tell how much scatter to expect in subsequent tests.

W J HILL, *Manager*
Statistical Services Section
Ford Instrument Co
Div of Sperry Rand Corp

ITEM—*When debugging an automatic machine which assembles a printed-circuit module, engineers found quality and reliability of the circuit could be predicted from just the characteristics of three critical components—a capacitor and two resistors. Closer control on these three then gave fewer rejects and reduced inspection time.*

ITEM—*A purchaser of precision potentiometers discovered a relationship between his test data and the test data supplied by the vendor. Time invested computing the relationship, 40 hours. Time saved in the receiving inspection departments: 4500 man-hours a year.*

ITEM—*Time and money were saved when engineers found that machined metal parts need not be tested to failure to assure satisfactory operation. Failure could be predicted by a nondestructive hardness test.*

Those are three examples of what regression analysis can do. It's a statistical tool that can compute an equation relating two variables when, because of scattered data, the relation doesn't appear simply by plotting data. It works either when the relation between the dependent variable y and the independent variable x is of the form

$$y = a + bx, \text{ or the form}$$

$$y = a + bx + cx^2 + dx^3 + \ldots$$

It can also discover a relation between several independent variables, x_1, x_2, x_3, . . . and a dependent variable y when the relation of each x to the y is a linear one and can be described by the equation

$$y = a + bx_1 + cx_2 + dx_3 + \ldots$$

Besides supplying the equation, the method enables you to show that the equation fits the data with a certain level of statistical confidence.

A typical problem

Assume you have a mechanical device in which output y apparently depends on placement of three critical components whose locating dimensions are x_1, x_2, x_3. Plotting each x against y seems to indicate a linear relation, but the data is so scattered that it is difficult to draw a straight line representing all points. The data for 10 test runs looks like this.

Test No.	x_1	x_2	x_3	y
1	26	10	1	12
2	30	5	4	27
3	24	8	8	32
4	26	8	4	23
5	32	10	1	14
6	28	8	8	33
7	20	7	10	33
8	22	6	6	26
9	34	9	5	29
10	26	3	10	39

Because there are more sets of data than variables, regression analysis can be called on to find an equation of the form $y = a + bx_1 + cx_2 + dx_3$. Values for the constants and coefficients can be found by using the "forward Doolittle" method.

First step: substitute data into the following matrix

n	Σx_1	Σx_2	Σx_3	Σy
	Σx_1^2	$\Sigma x_1 x_2$	$\Sigma x_1 x_3$	$\Sigma x_1 y$
		Σx_2^2	$\Sigma x_2 x_3$	$\Sigma x_2 y$
			Σx_3^2	$\Sigma x_3 y$

THE "FORWARD DOOLITTLE" METHOD

By sequence of steps, it reduces scattered data to four rows of values (shown in boldface). These values, after simple algebraic manipulation, give constants and coefficients of an equation that accurately represents relationship among the variables.

LINE NO.	MATRIX TO BE SOLVED					EXPLANATION OF STEPS
1	10	262	74	57	268	
2		7076	1950	1454	7020	
3			592	381	1864	
4				423	1767	
STEP 1	10 **1***a*	262 **26.26***b*	74 **7.4***c*	57 **5.7***d*	268 **26.8**	Divide by first figure (10)
STEP 2		7076 −(26.2)(262) 211.6 **1***b*	1950 −(26.2)(74) 11.2 **0.05***c*	1454 −(26.2)(57) −39.4 **0.19***d*	7020 −(26.2)(268) −1.6 **−0.01**	Subtract product: coefficient of *b* (step 1) times corresponding figure from line 1 Corrected line 2 Divide by first figure (211.6)
STEP 3			592 −(7.4)(74) −(0.05)(11.2) 43.81 **1***c*	381 −(7.4)(57) −(0.05)(−39.4) −38.72 **−0.88***d*	1864 −(7.4)(268) −(0.05)(−1.6) −119.12 **−2.72**	Subtract product: coefficient of c (step 1) times corresponding figure from line 1 Subtract product: coefficient of *c* (step 2) times corresponding figure from corrected line 2 Corrected line 3 Divide by first figure (43.81)
STEP 4				423 −(5.7)(57) −(0.19)(−39.4) −(−0.88)(−38.72) 56.55 **1***d*	1767 −(5.7)(268) −(0.19)(−1.6) −(−0.88)(−119.12) 133.83 **2.37**	Subtract product: coefficient of *d* (step 1) times corresponding figure from line 1 Subtract product: coefficient of *d* (step 2) times corresponding figure from corrected line 2 Subtract product: coefficient of *d* (step 3) times corresponding figure from corrected line 3 Corrected line 4 Divide by first figure (56.55)

where n is the number of sets of data. (Summing terms for the matrix is most conveniently done on a desk calculator. But for large, complex problems, a digital computer is recommended. It will make short work of regression analysis; the problem is a common one for computer work, and ready-made programs are available). Substitution gives

10	262	74	57	268
	7076	1950	1454	7020
		592	381	1864
			423	1767

Solving this matrix to find values for each of the unknowns, a, b, c, d, is shown at top of this page. The general technique is to use each line of the matrix to make an equation involving the four unknowns. The first line gives the first equation after dividing through by coefficient of a. Subsequent lines must be "corrected" by subtracting the effect of previous steps. The result is four equations in four unknowns:

$$a + 26.2b + 7.4c + 5.7d = 26.8$$
$$b + 0.05c - 0.19d = -0.01$$
$$c - 0.88d = -2.72$$
$$d = 2.37$$

and solving

$$a = 7.49$$
$$b = 0.40$$
$$c = -0.63$$
$$d = 2.37$$

The resulting equation shows the relationship between output y and the three critical components, x_1, x_2, x_3.

$$y = 7.49 + 0.40\,x_1 - 0.63\,x_2 + 2.37\,x_3$$

Check the results

To test validity of this equation, compare the variation removed by the equation with the variation that would have to be removed to make the result significant. The variation removed by the equation in each step of the solution can be found by multiplying together the last two figures in the y column of each step. (Normally this computation is made at the same time the matrix is solved.) Summing these:

$$(268)(26.8) + (-1.6)(-0.01) + (-119.12)(-2.72) + (133.83)(2.37) = 7823.03$$

and subtracting the sum from total variation, $\Sigma\, y^2$, gives a residual variation which represents variation not removed from the equation. These computations are best shown in tabular form:

	Variation	Degrees freedom	Mean square
Total Variation (Σy^2)	7838	9	.....
Removed by Regression Equation	7823.03	4	1955.76
Residual	14.97	5	2.99

The total variation has one less degree of freedom than the number of sets of data (n − 1 = 9). Degrees of freedom for the regression equation equals the number of terms (in this case, four). The residual variation —that not removed by the equation—has five degrees of freedom (simply the difference between the other two

values). Mean square is computed by dividing degrees of freedom into the variation.

To determine whether the equation is significant, compare the F ratio of the equation (variation removed, divided by residual variation: 1955.76/2.99 = 654.1) with the F ratio for a standard statistical distribution with four degrees of freedom in the numerator, five in the denominator and a confidence level, $\alpha = 0.05$ (tables for F ratio can be found in most statistical texts). The F ratio for these conditions is 5.19, much smaller than F ratio of the equation, indicating the equation fits the data most satisfactorily.

It is now possible to predict limits, both above and below the equation, between which any subsequent data will fall. These so-called "confidence limits" are computed from the residual-mean-square variation and the t distribution (tables for t distribution are also available in statistical texts). Here the upper and lower limits are:

$$y = 7.49 + 0.40x_1 - 0.63x_2 + 2.37x_3 \pm (2.57)(\sqrt{2.99})$$

where 2.57 is t distribution for five degrees freedom and $\alpha = 0.05$ (95% of all further data should fall within these two limits).

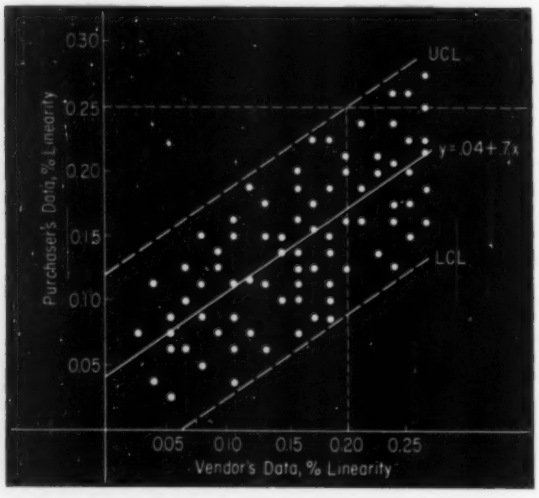
Other applications

As indicated by the three model equations, the "forward Doolittle" method can also find an equation when only two variables are involved. A typical example is the potentiometer case study where the problem was to relate vendor's and purchaser's test measurements.

Plotting vendor's against purchaser's readings gave a chart with a considerable amount of scatter but with the majority of data points oriented in what appeared to be a straight line. Therefore, using regression analysis, the purchaser attempted to fit the data to an equation of the form y = a + bx by solving this simple matrix.

n	Σx	Σy
	Σx^2	Σxy

The resulting equation, when plotted with the data and the upper and lower confidence limits, looked like this:



For the purchaser, potentiometers had to be linear within 0.25%. Because $\alpha = 0.05$, 2½% of the data will fall above the upper confidence limit and 2½% below the lower confidence limit. The intersection of the purchaser's 0.25% linearity level with the upper confidence limit gives a vendor reading of 0.20% linearity. Thus, when the vendor's data show that a group of the potentiometers have a linearity of 0.20%, the purchaser's data will show that only 2½% of them have a linearity worse than 0.25%.

Based on this analysis, test instructions were changed to read: "Test all potentiometers that have an indicated linearity in excess of 0.20%. In addition, test five randomly selected potentiometers from each lot." The final condition gave a continuing check on the functional relationship and assured that the vendor would not attempt to slip in unacceptable potentiometers with good data.

Nonlinear equations

When the relationship between two variables does not appear to be a straight line, a higher order equation may fit the data.

The model equation here is

$$y = a + bx + cx^2 + dx^3 \ldots$$

Following the pattern of the first example, the matrix to be solved is

n	Σx	Σx^2	Σx^3 ...	Σy
	Σx^2	Σx^3	Σx^4 ...	Σxy
		Σx^4	Σx^5 ...	Σx^2y
			Σx^6 ...	Σx^3y

The number of terms chosen will depend somewhat on the appearance of the data when it is plotted. Does it look like a quadratic curve or a cubic curve? This first estimate can then be checked as the matrix is solved by comparing the amount of variation removed in each step of the matrix with the total variation (Σy^2). When sum of variations removed at each step begins to get close to total variation, it is time to stop adding terms and check the equation for significance. Analysis of significance and setting of confidence limits are done with the F test and t distribution as before.

EDITOR'S NOTE: Statistical analysis formerly interested only those engineers in the Quality Control department, but is now finding many new applications in design work. A statistically designed experiment is one of the most important of these. For examples of this money- and time-saving test method, see "Experiments That Have Statistical Certainty," July 6 '59, p 66, "Latin Squares for Fewer Tests—Same Accuracy," May 12 '58, p 92; and "Design of Experiments—Blind Spot for Researchers," Sep 22 '58, p 34.

Digital and analog computers have been taking a larger and larger part of the engineer's calculating load off his shoulders. For further information on the problems and possibilities of computers see, "At the Edge of the Unknown," May 4 '59, p 27; "Solution By Analogy," Jan 26 '59, p 28; "Big Computers Solve Packaged Problems Economically," June 2 '58, p 28; "Are Computers Oversold?" Sep 9 '57, p 40.

Some Ideas

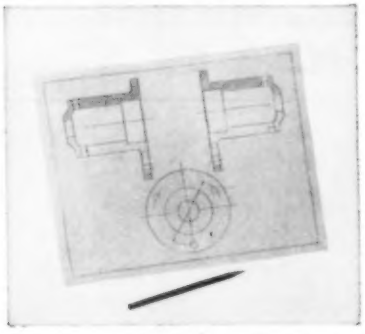
for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

A year of relentless testing has produced a small library of interesting facts about HERCULENE (T.M.) Drafting Film. What follows is a consensus of drafting-room experience with HERCULENE–by K&E and its customers–with some up-to-date recommendations for using it. Take the matter of . . .

Shiny Back vs. Pencil Back

A basic question is: do you need a double-surfaced drafting film? We make HERCULENE Drafting Film both ways, of course –with a single surface (shiny back) and double surface (pencil back). It's our recommendation that you use pencil back HERCULENE only if it's your practice to make basic drawings on one side, changes on the other. For most other uses, shiny back is preferable. (At first, the double-surface film was chosen by many drafting rooms because it lay flatter on the board than shiny back. This is no longer true. K&E research labs have come up with a fully effective anti-curl treatment.) Especially in filing, shiny back HERCULENE presents fewer problems. The clean non-abrasive back won't smudge the face of the sheet underneath, even in a heavy stack of tracings. If you'd like to compare a few sheets, please let us know.



Note sharp clear lines made by Duralar pencil on HERCULENE Drafting Film.

Plastic Pencils and the HERCULENE Surface

Not just a handy catch-phrase, when K&E puts its exclusive "engineered surface" on a drafting material, the result is an exact, uniform tooth for sharp pencil drawing, inking and typing. With HERCULENE Drafting Film, however, an entirely new type of plastic (non-graphite) pencil yields especially good results. Quite a few of our customers have reported favorably on the well-known Staedtler "Duralar" brand. Duralar pencils come in five hardnesses, are non-smudging and have generally good covering power, sharpness and erasability. After about 20 prints, the Duralar lines show up consistently better than those made by a regular pencil, since graphite lines tend to lose density.

Wet That Eraser!

The erasing qualities of HERCULENE Drafting Film are excellent, but (as with the pencils) we've discovered it's a new type of vinyl eraser that gives the best results. Examples of these non-rubber type erasers are the Richard Best "TAD" and the Eberhard Faber "RACE KLEEN" – both available from your K&E dealer. With vinyl erasers, pencil lines whisk off. Even stubborn ink and typing can be removed easily, with no damage to the surface. Here's a tip on how to do this:

Moisten the eraser slightly. It becomes no more abrasive, but a lot more "erasive." Moistening is a must when removing Duralar lines or typing after exposure to heat. (Incidentally, don't use electric erasing machines, steel erasers or typewriter erasers.) When erasing large areas, certain chemical eradicators work fine too. Our suggestion: use Vythene or a very light application of a denatured alcohol such as Solox, both of which can be applied with a cotton swab or clean cloth.

The Cleaner the Better

HERCULENE Drafting Film was designed for ink work, and its ink take is unexcelled. But like all films, its non-absorbency makes a few preparations advisable. The surface should be cleaned thoroughly before inking. Quickest and most effective way to do this is with the ABC Draftsman's Dry-Clean pad, which will remove finger marks and "traffic film" simply by rubbing the pad over the surface. Pouncing will also work well. A damp cloth is all right for general cleaning, but does not do the best job of preparing the surface for ink.

Inking over graphite pencil lines comes out best when done over light lines, drawn with a harder grade of pencil. A good way to remove excess graphite is to go over the drawing with an ABC pad. Inks vary in their usefulness on HERCULENE. We've tested several, and you're welcome to these results as well, on request.

After Typing, Please Pounce

Typed impressions on HERCULENE Drafting Film are crisp and sharp, but may take a while to dry because the film's surface doesn't "swallow" ink readily. A light pouncing right after typing will dry the ink and fix the lines – giving you uniform permanent contrast.

A new typewriter ribbon will produce the best impressions. At K&E we've tested a healthy variety of ribbons and we'd be pleased to send you the results on request.

Outstanding Advantages Proved In Tests

We're pleasantly amazed at the short time it took for HERCULENE Drafting Film to become an accepted "staple" – along with ALBANENE® Tracing Paper and PHOENIX® Tracing Cloth. Actually, it's a rare drafting room by now that has *not* tested HERCULENE during its first year on the market. The findings: All properties considered, HERCULENE stands up better than any other drafting film. It has great resistance to heat, aging and abuse. Its exclusive "engineered surface" plus its tough, durable Mylar® base provide superior pencil and ink take, fine erasability, remarkable dimensional stability...a combination we're proud to call unbeatable!

The K&E dealer near you has HERCULENE now. Stop in and see him.

KEUFFEL & ESSER CO., Dept. PE-7, Hoboken, N. J.

Please send further information about HERCULENE Drafting Film. I'd like samples too.

Name & Title _____

Company & Address _____

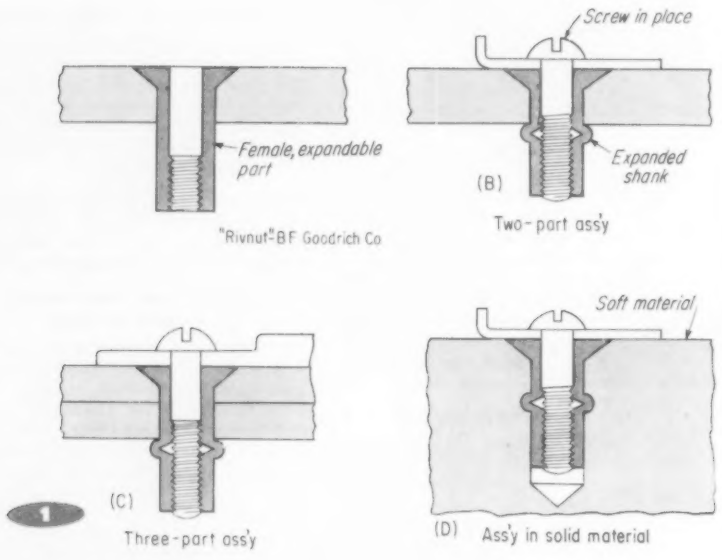
_____

2001

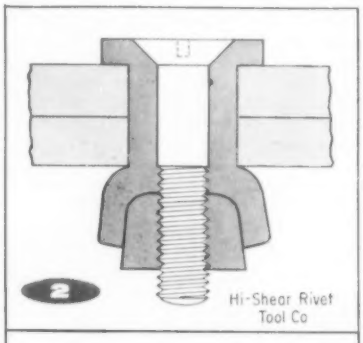
29 Blind-side

A selection of commercially available and "home-made" devices that allow mechanical joints to be made from only one side of an assembly. Federico Strasser, Santiago, Chile, is credited for much of this material.

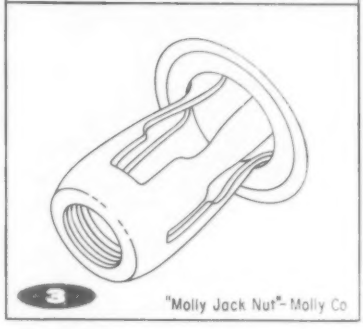
Most of the fasteners illustrated here are basically expanding rivets—even though some of them act as inserts. The means used to expand them are: screws, mandrels and explosives. Some of the ways whereby these principles make the one-side fastener feasible are configurated in this four-page roundup.



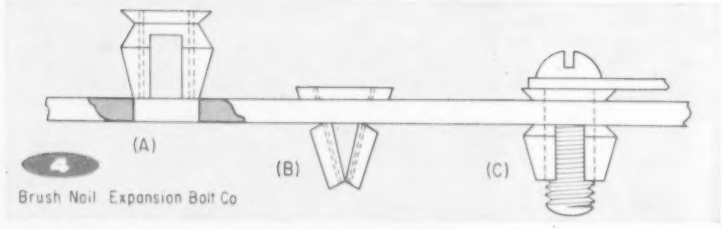
1



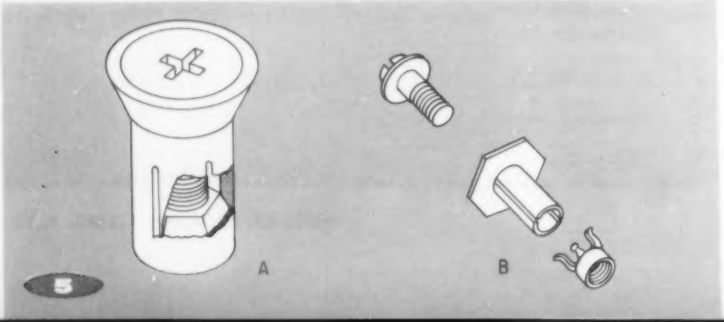
2



3



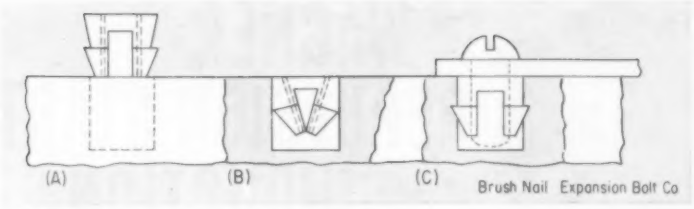
4



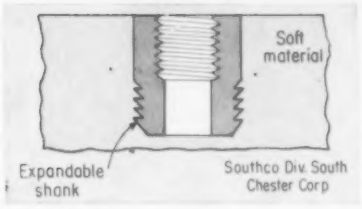
5

Collapsible and expandable rivets . . .
have shanks that are either solid (1, 2) or notched (3, 4, 5). The notched types will, generally, withstand lower stresses than the solid-shank rivets. Sometimes, threaded rivets are called rivet-type nuts.

Fasteners

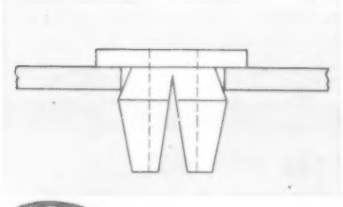


6



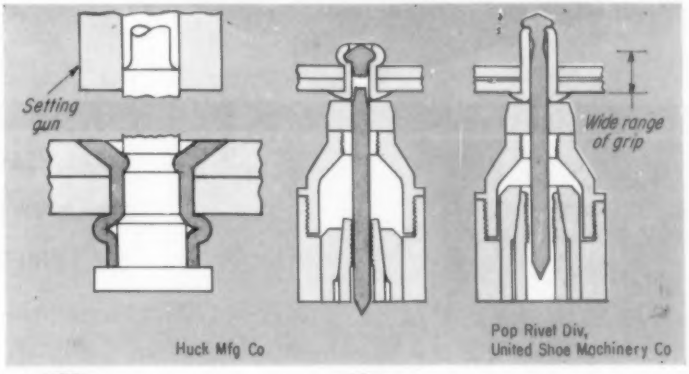
7

Expandable inserts . . .
(6) work on same principle as rivets. Shank of insert (7) is serrated; when screw is driven into insert the serrated shank is expanded by OD of screw.



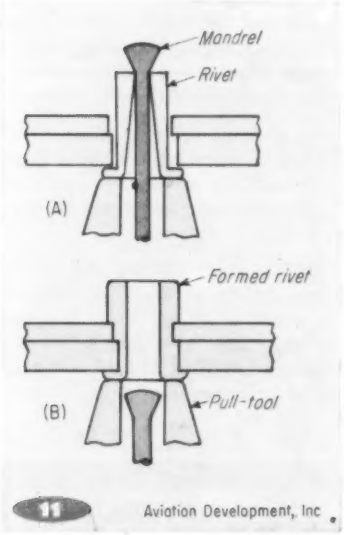
8

Plastic rivet . . .
although not threaded, comes in this class because it is expanded by a self-tapping screw to provide a semirigid fastener.



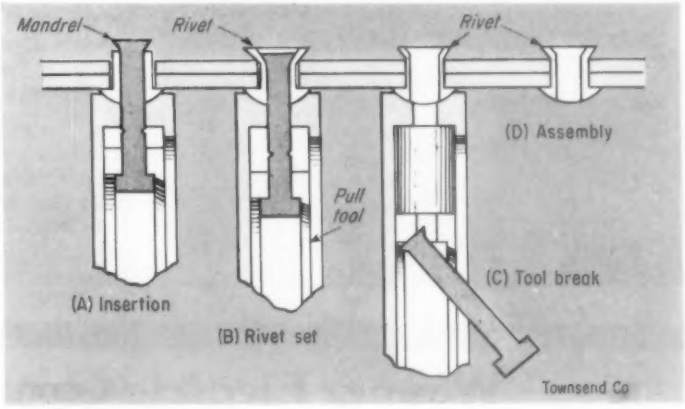
9 10

Break-"stem" mandrels . . .
are "pulled through" to set rivet, but the stem breaks off and remains in the rivet (9, 10).



11

Pull-through mandrels . . .
that allow permanent setting of blind rivets were originally developed in France—the Chobert rivet. It adjusts for slight misalignment of hole.



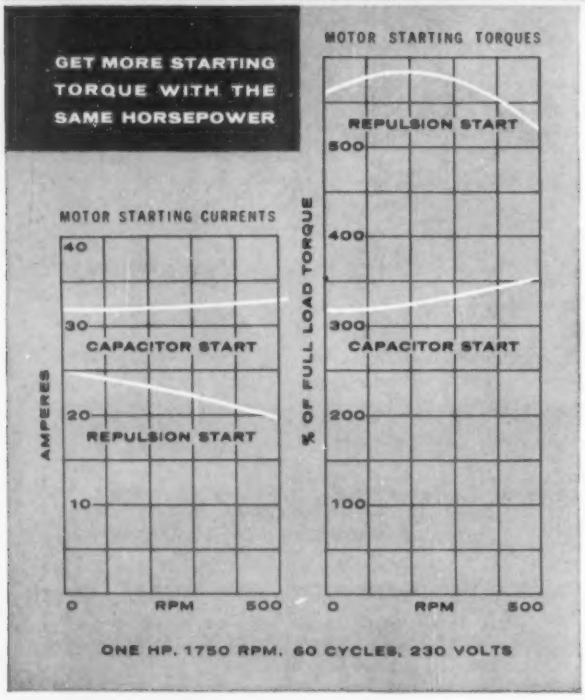
12

Break-"head" mandrels . . .
leave rivet hollow after setting. Advantages: weight saving and appearance.

(Continued on page 69)

TOUGH STARTS MADE EASY...

WAGNER REPULSION-START INDUCTION MOTORS



START HEAVY LOADS WITH EASE

STAND UP UNDER LONG SERVICE

USE EXTREMELY LOW STARTING CURRENT

Starting heavy loads is a natural for Wagner Type RA Motors. Widely used for high starting torque applications, like farm machinery, compressors, pumps and grinders, this rugged single phase motor requires very low starting current that minimizes light flicker. You get smooth performance with a constant high operating speed, even under overload, and a flat efficiency curve over a wide operating range.

You practically eliminate service problems when you power tough single phase applications with these motors. They have unmatched ability to start high inertia or heavy friction loads repeatedly and they give many years of unfailing service.

You can get these motors from leading motor distributors in your community or through Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-220 gives full details on Repulsion-Start-Induction Motors.

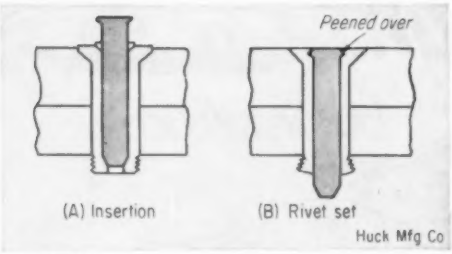
WH59-8

Wagner Electric Corporation

6406 PLYMOUTH AVENUE, ST. LOUIS 14, MISSOURI

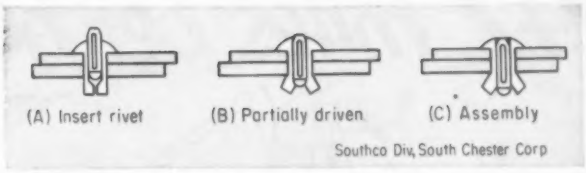
SERVING 2 GREAT GROWTH INDUSTRIES ... *ELECTRICAL ... AUTOMOTIVE*

Blind-Side Fasteners (CONTINUED)

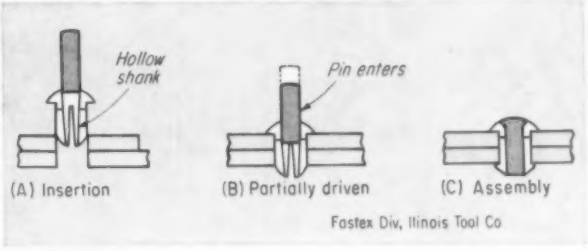


13

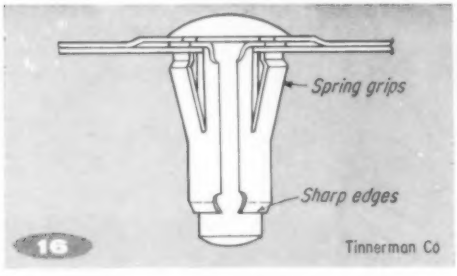
Plug mandrels . . .
or drive-pins force rivet shank to expand to provide permanent assembly. Mandrel remains in rivet after setting. Drive-pin rivets (13) are two-part, factory-preassembled. Lip section is peened over to lock pin after it is driven. Drive-rivets (14) are similar in principle but different in configuration. Plastic rivets (15) are ideal for light-duty blind fastenings of anything from paperboard to metal. They are available in a wide variety of thermoplastic materials.



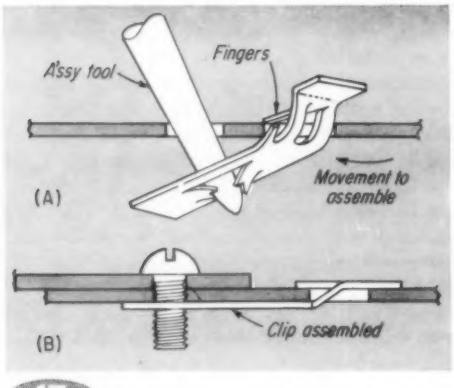
14



15

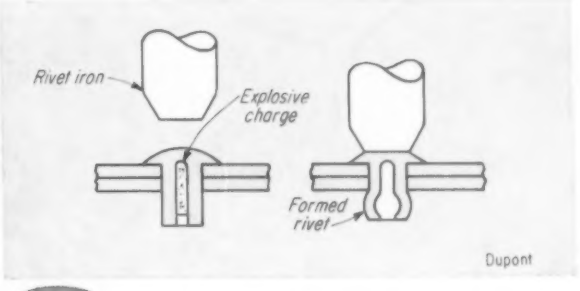


16



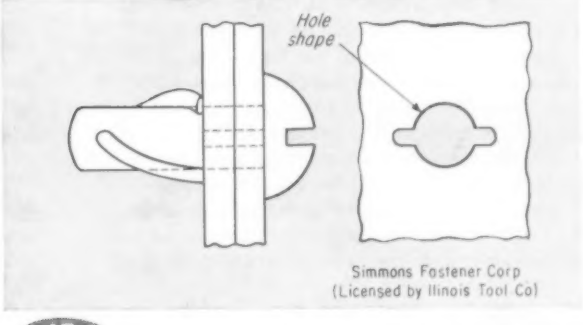
17

Spring clips . . .
of various designs can often serve as blind-side fasteners. Tubular clip (16) is pushed into hole and held by internal spring grips. Stud pushed into clip is gripped by sharp edges of clip. "Speed" clip (17) is held by spring finger at one end until blind-side assembly is completed with screw.



18

Explosive rivets . . .
have charge in shank that is exploded by heat from an electric gun. Charged end of shank is expanded by the controlled explosion, thereby forming a head on the blind side of the assembly.



19

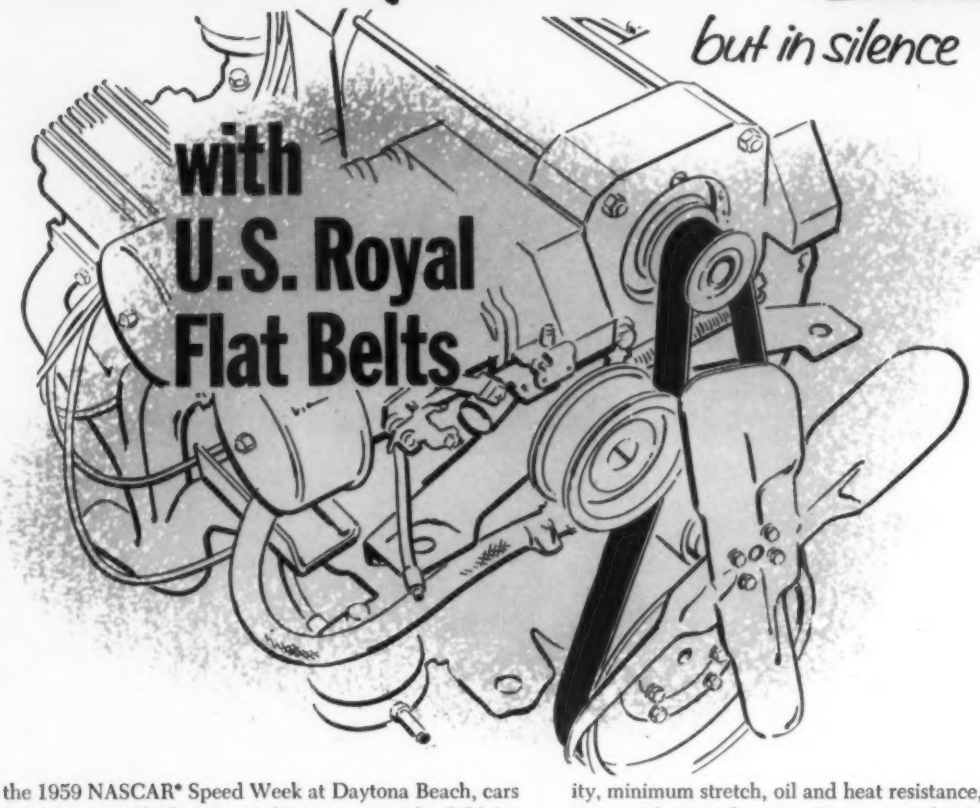
Spring legs . . .
are twisted into spiral with first quarter-turn of this fastener; a second quarter-turn clamps the assembly together; a third quarter-turn releases the fastener.

(Continued on page 71)

ROYAL FLAT BELTS

147 miles per hour...

but in silence



In the 1959 NASCAR* Speed Week at Daytona Beach, cars with Latham Axial Flow Superchargers swept the field for the second straight year. Top speed for one of these cars was 147 m.p.h.

Every Latham Supercharger is equipped with a U.S. Royal 1½"-wide heavy duty drive flat belt. This is the main reason why the compressor runs so silently, so dependably. This "U. S." belt effectively handles the high-speed, high-load requirements of this drive with no stress or strain. In delivering smooth, quick power to the compressor, it easily resists destructive heat build-up. The performance of this belt on such a gruelling assignment demonstrates how effective this belt can be on tough drives on all types of machinery.

U. S. Royal Flat Belts are made with special constructions to service all types of drive conditions. They are furnished in combinations of high tensile strength, maximum flexibility, minimum stretch, oil and heat resistance, static conductivity with special covers. In most combinations the length is stable or shrinkless.

Combinations of these constructions provide a correct flat belt for every purpose—from light to heaviest duty, as well as the most abnormally severe operating conditions, such as, for example, in the Latham Supercharger.

The U. S. Royal Flat Belt offers the design engineer the assurance that here is a belt that will stand up to his most exacting design requirements, and will be equally effective as a replacement belt for existing equipment.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

*National Association for Stock Car Auto Racing

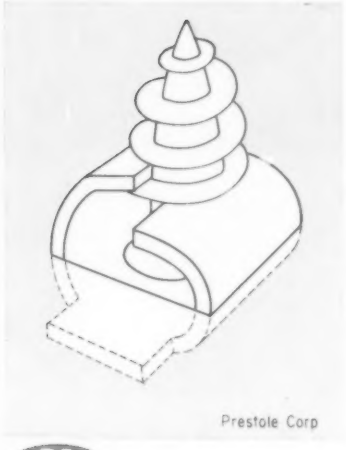
Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

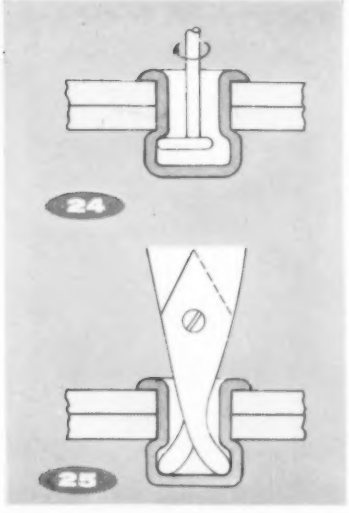
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Blind-Side Fasteners (CONTINUED)



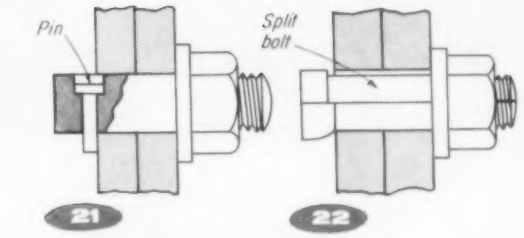
20

Expanding snap nut . . .
is similar to expanding rivet. Nut is pushed into hole and subsequent expansion of thread-engaging member spreads fastener out so that it wedges tightly in the hole.

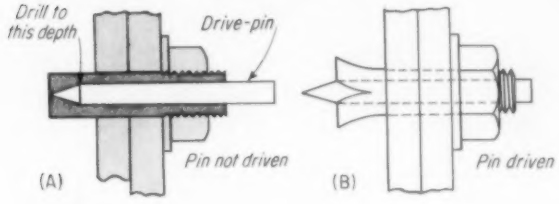


24 25

Internally spun . . .
tubular rivets are basically flanged shells in which the bottom is expanded to set rivet either by spinning (24) or special pincers (25). After setting, rivets may be filled with metal plugs or plastic resin.

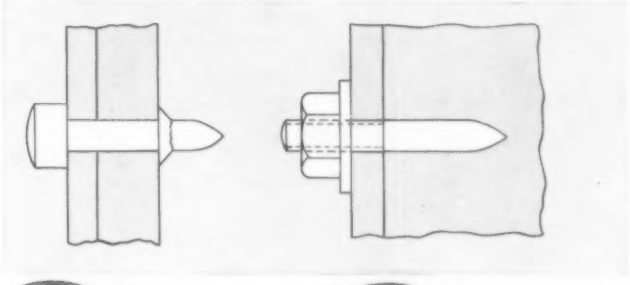


21 22



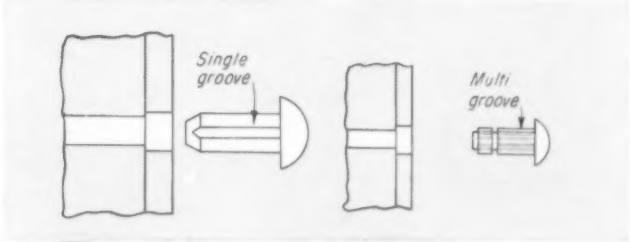
23

"Home-made" devices . . .
for blind assembly are usually necessary when comparatively large fasteners are involved. Headless stud (21) has small pin whose total length equals bolt diameter. Pin drops through bolt on assembly and retains blind end in work. Only comparatively light tension may be put on bolt. Max tension is possible when split bolt (22) is used. Drive-pin type fastener (23) can be made to suit special fasteners by drilling threaded rod.



26 27

Powder-actuated fasteners . . .
are threaded, knurled, or smooth. Analogous to a bullet, they are fired into panels (26) or solid parts (27) by a controlled explosion.

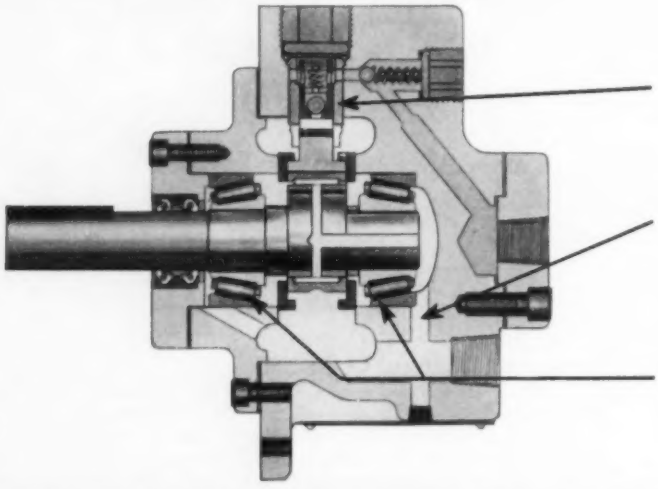


28 29

Drive-pins . . .
are efficient, low-cost fasteners that may have either single (28) or multi-grooved shanks (29) for materials with plastic flow.

AT PRESSURES TO 5,000 PSI . . .

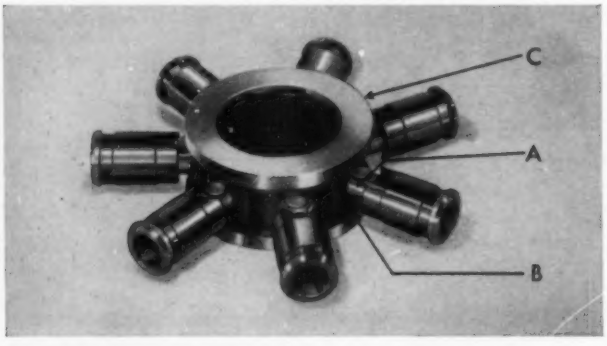
Only the AE Hydramite offers all these advantages



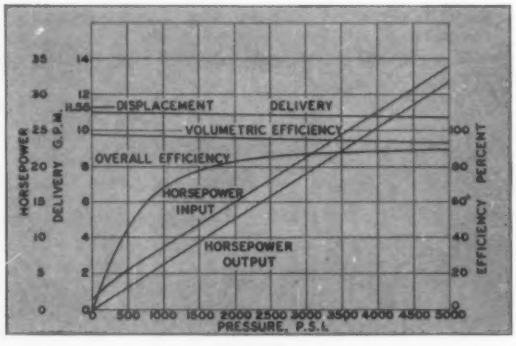
Liners and plungers are honed and individually mated for optimum fit.

Low friction losses. Pump operates with case flooded. Oil is ported to take advantage of natural pumping action of tapered bearings.

Heavy duty, high capacity tapered roller bearings absorb more punishment . . . handle maximum unbalanced loads . . . last longer.

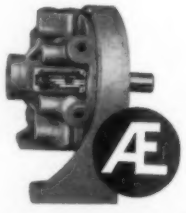


Positive pumping action. The Hydramite has no cam follower springs to fail. Plungers (A) are connected to curved slippers (B) which are held against the outer race of cam shaft needle bearing by two plunger return rings (C). As the shaft revolves, each plunger is pushed outward in succession and then pulled inward by the return rings.



High efficiency. With a Hydramite you get an overall efficiency of 85%. Its flat overall high efficiency curve has little variation between 1,500 and 5,000 psi. What's more with a Hydramite you get positive suction. There is no requirement for supercharging equipment which deducts from system efficiency.

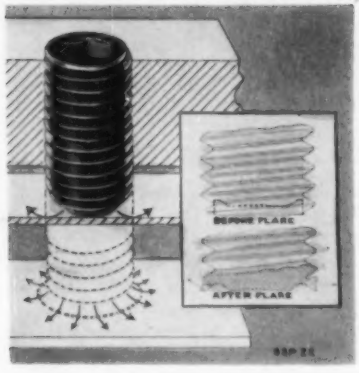
To meet your specific requirements, Hydramite pumps can be supplied for constant displacement from 3 to 30 gpm at 5,000 psi and 70 to 85 gpm at 3,000 psi for hydraulic fluids with viscosities of 150 to 300 ssu at 100° F. In special applications they have handled viscosities as low as 40 and as high as 900 ssu at 100° F. Special materials and seals permit handling of missile fuels and special fluids at higher temperatures. Available in flange, foot or face mounted styles. Contact American Engineering Company, Dept. P-148, Philadelphia 37, Penna. Phone: Cumberland 9-3800.



AMERICAN ENGINEERING COMPANY

Hele-Shaw Pumps, Lo-Hed Hoists, AE Marine Deck Auxiliaries, Vibra Grate, Perfect Spread and Taylor Stokers.

SIGNIFICANT COMPONENTS MATERIALS PROCESSES

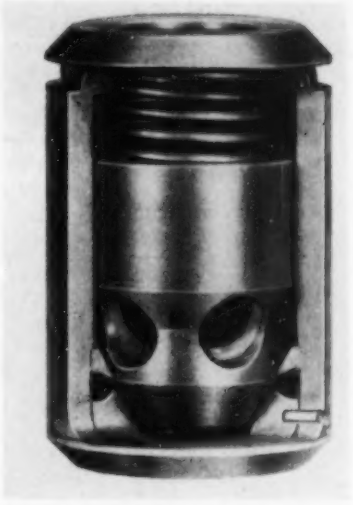


Setscrew also provides grip . . . because specially formed point flares out when tightened against bearing surface. Once flared, screw becomes tightening or adjusting screw. It will not continue to flare with successive tightenings, but retains compressed position that gives it point-gripping power similar to cup point action. Also available with flat point. Screw may be removed at any time, if necessary, without damaging mating thread. Available in most metals in hex, slabbed or slotted heads. Prices are said to be competitive with other locking screws. **Set Screw & Mfg Co, Bartlett, Ill.**

Circle 300, Reader Service Card

Solenoid air valve . . . can be actuated by hand, whether coil is energized or deenergized, when desired. Suitable for all low-pressure air systems to 150 psi, whether manual control is part of normal production setups or needed as emergency feature. In latter instance, manual lever can be safety-wired to prevent accidental actuation. Permits check of electrical and operational failures in a system without halting production. 4-way valves are $51.40, $57.60, $66 and $91.25 for ¼, ⅜, ½ and ¾-in. sizes. From stock. **Barksdale Valves, 5125 Alcoa Ave, Los Angeles 58.**

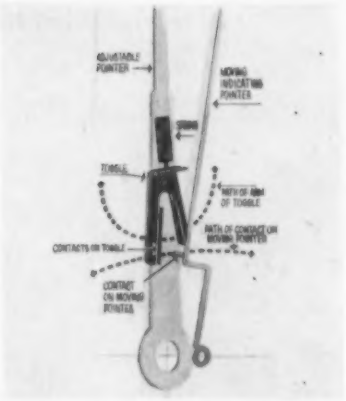
Circle 301, Reader Service Card



Cartridge-type check valve . . . makes possible design simplification and reduction of size of hydraulic and pneumatic circuits. Usable in subplate and manifold block assemblies, in pump suction inlets, in pump conversions and similar installations. Said to be leakproof at all pressures, to maintain low pressure drop at full flow and to eliminate threaded connections. Steel cartridge is equipped with Buna-N seal for use in general-purpose oils, lubricants, hydraulic oil, air and water with working pressure to 3000 psi, surge flow protected. Built to operate in temperatures of —40 to 300 F with cracking pressure of 1 to 2 psi. Depending on quantity, priced from $2.26 to $1.50 and $2.74 to $1.72, respectively, for 5½- and 17-gpm units. From stock. **Kepner Products Co, 7341 W 59th St, Summit, Ill.**

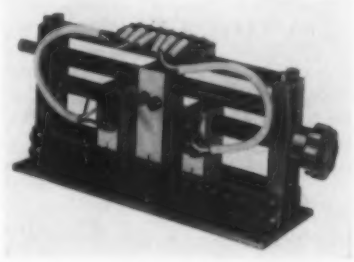
Circle 302, Reader Service Card

Continuous-reading meter . . . shows signal level even when set point has been passed and control circuits have been energized. Circuits remain operative until reset calls for opposite action. Control action begins when round vertical



contact on indicating pointer meets flat contact on toggle mounted beneath adjustable pointer. Moving pointer, with torque increased by booster coil, then passes toggle and continues to show actual signal strength, while load relay remains energized. When signal returns to set point, indicating-pointer snaps toggle the other way and reverses control action. Since sampling is not necessary, several auxiliary control components can be eliminated. Sensitivities and selection of scale ranges (0 to 5 microamp) are the same as for other meter relays. **Assembly Products Inc, 75 Wilson Mills Rd, Chesterland, Ohio.**

Circle 303, Reader Service Card

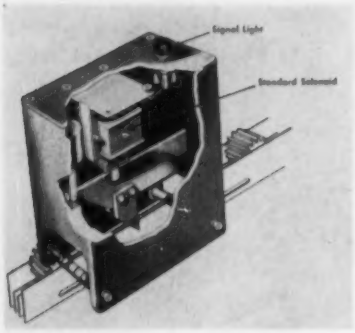


Limit-stops for mechanical . . . and electromechanical motions are offered in two types, now available for 24-hr delivery. BP-522 provides electric and mechanical operation limits by deenergizing drive immediately before mechanical limit is reached, thus preventing mechanical shock loads. Manually adjustable to limits between 1 and 100 revolutions of input shaft. Stop positions are indicated by two index blocks and direct-reading linear scale. BP-525 is cam-operated to provide circuit

. . . . CONTINUED ON PAGE 74

make-or-break points over any desired rotational arc. Cam assemblies are available to cover combined ranges in degrees of valley of either 0 to 180° or 180 to 270°. BP-522 unit is $98.50; BP-525, $14.50. Delivery, 24 hr after receipt of order. **Helipot Div, Beckman Instruments Inc, Fullerton, Calif.**

Circle 304, Reader Service Card



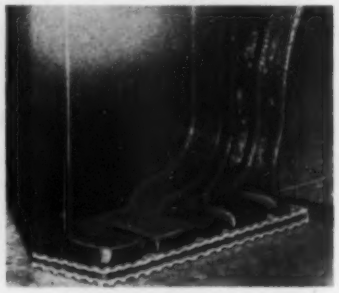
Interlock for parts-chutes . . .

based on standard line switch unit indicates parts accumulation at a given point in automatic handling systems, producing an electrical signal that can be used to control any machine, fixture or handling function. Another type of interlock, a shot bolt, permits or prevents part flow and can be operated automatically or manually from remotely located pushbutton. With solenoid or pneumatically operated stop-bars arranged to deflect parts into outlet chutes, multiples of unit can be used to distribute and feed parts to up to five machines. Counterweight can be adjusted to actuate switch based on weight of one part or accumulated weight of two or more parts. Both interlocks are installed on-site and can be relocated. Said to be adaptable to part changes and use standard electrical components. Both are available in five models that handle part sizes up to 6 x 4 in. cross-sectional area. **F Jos Lamb Co, 5663 E Nine Mile Rd, Detroit 34.**

Circle 305, Reader Service Card

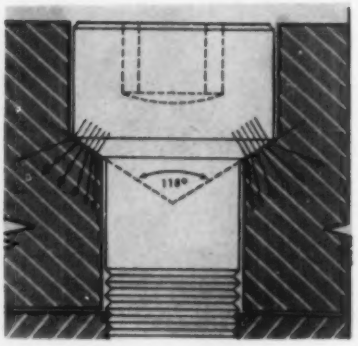
Vibration is absorbed . . .

by synthetic material composed of elastomeric vinyl plastic reinforced with monofilament fiberglass. Fused in layers under heat and high pressure into an integrated unit, it is said to eliminate 90% of destructive vibrational tremors and noise caused by machines. Outer layers are made of resilient low-density composition, while central core is high-density hard structure. Vibrational wave meets three different natural frequencies, preventing resonance and isolating vibration. Resists chemicals such as oils, greases, detergents and solvent cleaners. Parallel



outer surfaces keep machines level and vacuum suction cups molded into these surfaces combine with natural gripping of vinyl to prevent creep. Suitable for machines from 100 lb to 100 tons. Breaking strength is 7500 psi. Cost of equipping average machine with antivibration material is usually under $10 according to manufacturer. **Lowell Industries Inc, Boston 34.**

Circle 306, Reader Service Card



Socket head cap screw . . .

with tapered flange in head design provides 16.66% more bearing surface without increased head size and creates locking effect that requires 12 to 23% more torque to release. Self-aligning screws are reported to seal against leakage of oils, liquids and gases. Standard drill machines 118° angle, and existing applications can be converted to new screws by adding angle to top of clearance hole. Standard in all regular socket head cap screw sizes in diameters from No. 4 through 1½ in. Said to be competitively priced. **Mac-It Parts Co, Lancaster, Penna.**

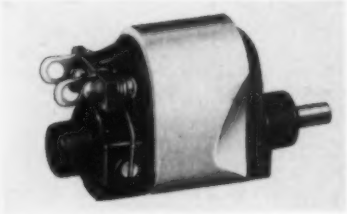
Circle 307, Reader Service Card

Microminiature panel meter . . .

measures $\frac{7}{8}$ in. dia and is available as a dc microammeter, milliammeter, ammeter or voltmeter. Two models can also be supplied as rectifier-type ac instruments. Sealed unit includes external pivot D'Arsonval movement and high-flux-density

Alnico magnet. Accuracy is said to be 5% of full face. Can have magnetic or nonmagnetic calibration. Scale background can be white or black. Lance-type pointer is offered in choice of colors. Terminals include one solder lug and single wire lead. Model SC-030, with face plate and hex nut, is also available. Housing is steel and both models meet watertight specifications of MIL-6b. **DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, NY.**

Circle 308, Reader Service Card



Miniature dc motor . . .

uses special magnet design to achieve high starting torque at operating speeds upwards of 20,000 rpm in unit that weights 1.4 oz. Open-frame motors are available for operation on any dc voltage between 3 and 30 v, with armatures wound to produce any desired no-load speed between 5000 and 30,000 rpm at specified input voltage. Locked-rotor torque is about 0.5 in.-oz, with working torques ranging from 0.4 to 0.1 in.-oz between output speeds of 5000 and 20,000 rpm. With constant load, speed is said to be almost linear function of applied voltage, permitting accurate speed control by varying input voltage below rated value. Suitable for high-performance intermittent-duty use in light-weight portable equipment. **Cramer Controls Corp, Centerbrook, Conn.**

Circle 309, Reader Service Card

Sealed-grease caster . . .

has neoprene wheel said to resist oil, grease, fatty acids and similar substances and pressure grease fitting that prevents

. . . CONTINUED ON PAGE 76

how to specify airline controls...

that provide longer life... maximum efficiency and protection of air-operated equipment

ALEMITE "TRI-DUTY" AIRLINE CONTROLS GIVE 3-WAY PROTECTION OF AIR-OPERATED EQUIPMENT

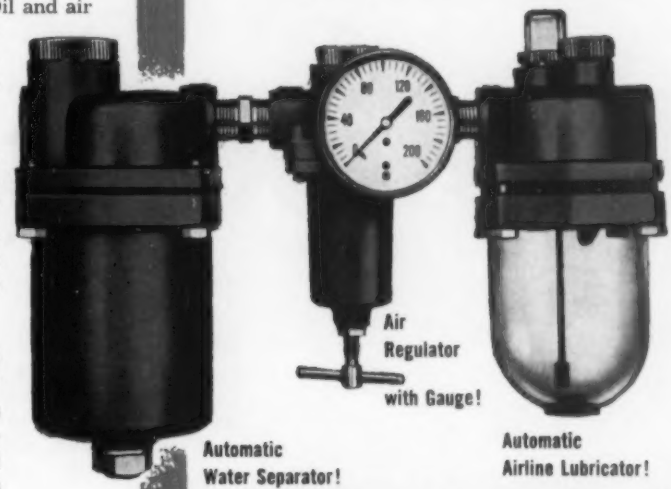
USE THIS HANDY CHECK LIST...

✓ **Are the controls uniformly and automatically lubricated?** "Tri-Duty" is equipped with an automatic airline lubricator. Exclusive compensating ball valve design controls air flow. Oil particles are atomized for most efficient transmission through supply lines. Result—uniform mixture regardless of air pressure and volume. Oil and air mixture proportionately constant. Reservoir may be filled at any time, assuring continuous operation. Nine-ounce capacity.

✓ **Is cleaning of the water separator filter quick, easy?** The Automatic Water Separator in the Alemite "Tri-Duty" system features an easily accessible filter. It unscrews by hand for simplest possible cleaning. There's just one piece. No tools required.

✓ **Will it deliver peak performance at all times**—even under adverse conditions? Alemite "Tri-Duty" airline controls provide a complete package that assures cleanest, driest, best-regulated lubrication of air cylinders, air motors and all air operated equipment. Designed specially for long service life and peak efficiency under adverse operating conditions.

✓ **Will the controls protect sensitive airlines from water, dirt?** "Tri-Duty" features an automatic water separator. Removes all condensate all the time. Traps dirt particles—prevents damage to airlines. Handles all airline pressures up to 200 PSI and flow volume from 5 to 50 CFM.



Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

Alemite Division of Stewart-Warner, Dept. AA-79
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a free copy of your "Tri-Duty" Airline Controls catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

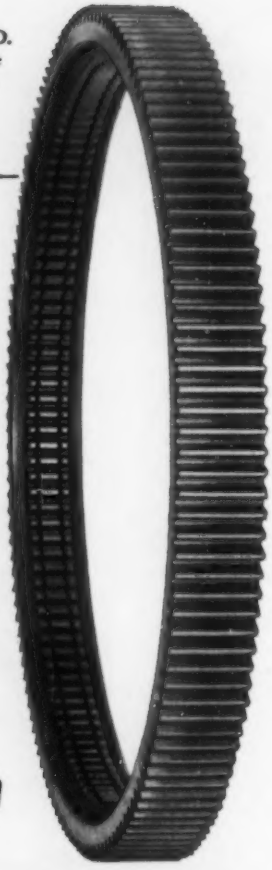
NAME .....

COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

Snap-ring grooves in this 12" O. D. thin-section *Reduction Drive Gear* are machined before carborizing and hardening. Both spline and gear teeth are ground and held to .001" excentricity after hardening the entire gear.



When you

DRIVE

for profits,

GEAR

with

PERKINS

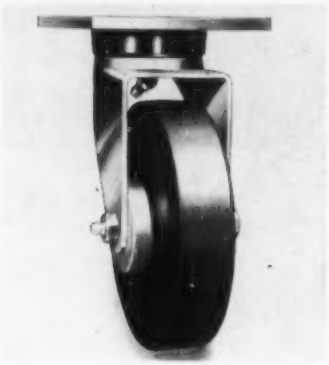
MACHINE AND GEAR CO.

Dept. 82 West Springfield, Mass.

Men who *know* will tell you that custom precision gears made by Perkins can eliminate many design, production and maintenance headaches — literally help you drive for better profits. When you want precision gears in experimental or production quantities, chances are you'll save time and money by checking with Perkins first. What is your gear problem today?

This Handy Gear Calculator, easy to use, saves time. *Folder* illustrating Perkins custom precision gears and facilities offers information. Both yours on request.

Most machining operations on this *Drive Gear Shaft* are performed after localized hardening with the cored areas at Rockwell C42. External spline and gear teeth are ground with splines held to precision tolerances.



entrance of dirt and abrasives. Flush top plate is standard 4 x 4 in., with 3 x 3-in. hole spacing, and stud recessed to prevent accumulation of foreign material. Buna-N grease seal retains protective grease but permits old grease to be purged. All meeting surfaces are 90° or greater, with ½-in. clearance between top of fork and wheel tread and between side of fork and side of wheel. Meets specs of Bakery Industry Sanitation Standards Committee. **Jarvis & Jarvis Inc, Palmer, Mass.**

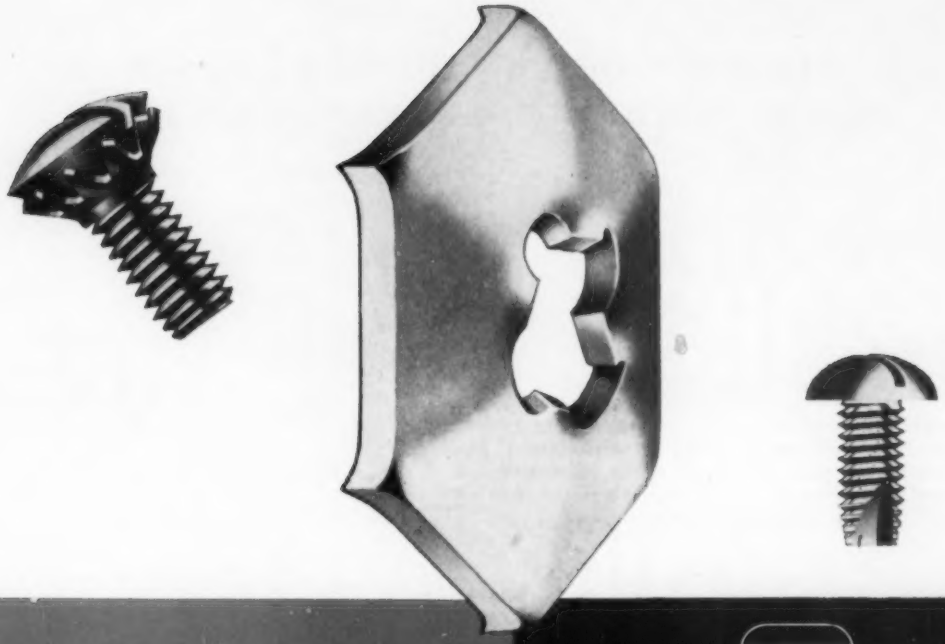
Circle 310, Reader Service Card

Linear displacement pickups . . . in two models, are ready for connection to required preamplifier and input source. Transducers include differential transformers, are encased in stainless steel shields and have carbide-tipped, spring-return contact rods, 10-ft integral cable and suitable adapters. Both models have max stroke of 0.050 in.; 0.5% linearity; operate from 5-v, 2400-cps excitation. Resolution is infinite and choice of 100, 25, or 10-gm contact pressures is available. One model is for flange mounting; other for mounting in tapped hole. **Industrial Div, Sanborn Co, 175 Wyman St, Waltham 54, Mass.**

Circle 311, Reader Service Card

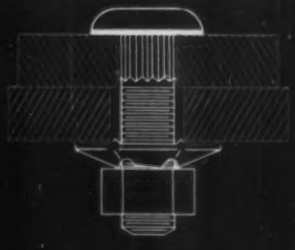
High-tensile bearing bolt . . . with self-locking hex nut requires no washer or torquing. Applicable where high clamping force is not needed or cannot be obtained. Relatively hard, tapered ribs facilitate driving and ribs burnish grooves, but do not peel while being driven, pre-

(Continued on page 80)



HOW TO SELECT
COST-SAVING

fasteners for heavy duty applications



A TYPICAL EXAMPLE:
How to Fasten Securely to Avoid Shifting

Where considerable tension in the fastening is needed to keep the parts from shifting, the Shakeproof®-developed Pyramidal Lock Washer* should be used. This washer spans large clearance holes — provides tension needed to keep parts securely fastened and in alignment.

*U.S. Pat. No. 2,794,476

For want of the right fastener, man-hours and money are often needlessly lost! It's vital to economical assembly line production to specify fasteners for each application that will do a fast and effective job *every* time. Fasteners engineered by Shakeproof assure maximum locking, reduce handling, and provide many additional functions that save assembly time, reduce production costs and improve your product's quality.

SEND FOR NEW SHAKEPROOF BULLETIN NO. 200

Shows typical examples of money-saving fasteners developed by Shakeproof engineers for heavy metal applications. Offers testing samples. Write for your free copy today!

SHAKEPROOF
"FASTENING HEADQUARTERS"®
DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois
In Canada: SHAKEPROOF/FASTEX
Division of Canada Illinois Tools Limited, 67 Scarsdale Road, Don Mills, Ontario

FAST, HAMMER-DRIVEN RIVET ECONOMICAL FOR BLIND AND OPEN APPLICATIONS

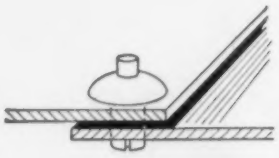


Fig. 1 Inserted in hole, Southco Rivets are quickly set by driving pin with hammer. No special tools are required. Bucking is not necessary.

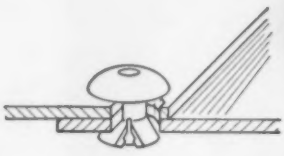


Fig. 2 Expanded prongs force sheets or parts together, hold them tightly in compression. No metal is removed, no grinding or finishing is required.

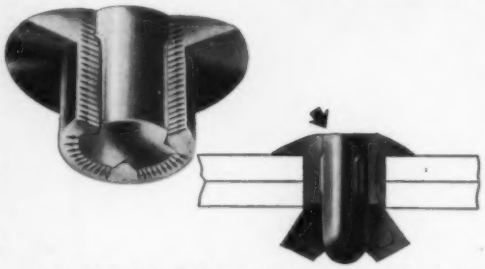


Fig. 3 Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

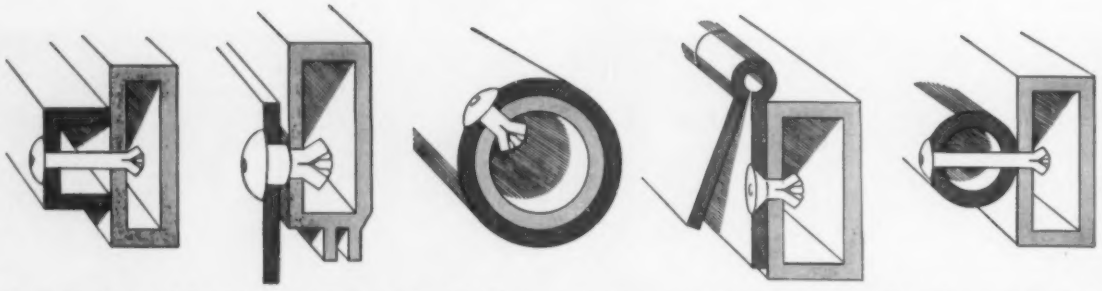


Fig. 4 Ideally suited for "blind" applications, Southco Rivets are worked by one man from one side only and require minimum space inside closed area. They eliminate costly bucking arrangement or time-consuming finishing. Supplied as a unit, they require no job time for assembly or fitting.

Fig. 5 Access or open fastening utilizes the simplicity, speed and vibration-resistance of Southco Rivets.

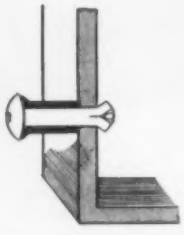


Fig. 6 Ferrules are used as spacers for numerous applications. Here the Southco Rivet forms a drawer pull in conjunction with a flanged tube.

Fig. 7 Increased head size distributes holding pressure over larger area, permits higher loading on wood, plastics and similar materials.

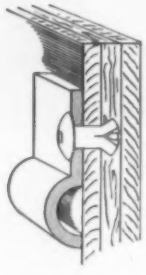


Fig. 8 A blind head can be formed inside the wood. This application is particularly useful when it is desirable to have one surface of the wood unmarred.

FREE

RIVET FOLDER

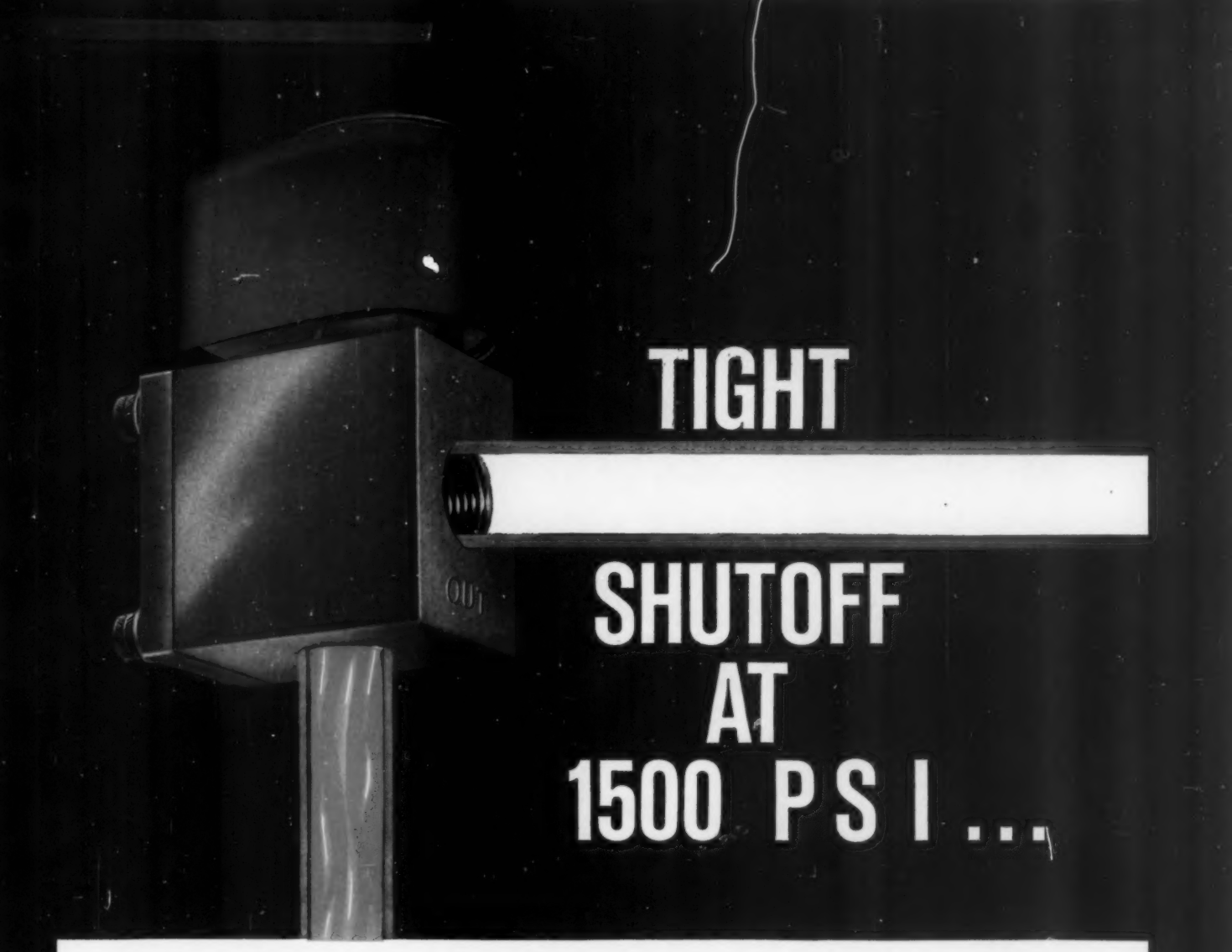
Send for your free copy of "Southco Drive Rivets" Folder. Gives complete information on the application, installation, and specifications of aluminum and steel Drive Rivets.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pennsylvania.

SOUTHCO FASTENERS

©1957

LION



TIGHT SHUTOFF AT 1500 PSI...

WITH ASCO'S 2-WAY HIGH PRESSURE SOLENOID VALVES

The ASCO Bulletin 8223 solenoid valve is a heavy-duty type designed for tight shutoff at high pressures. It is especially suited to hydraulic applications, such as hydraulic lifts and elevators – and missile launching platforms.

Features:

- **Operates in any position**
- **Operating Characteristics:** Pressures to 1500 PSI. Temperatures to 200°F. Pipe Sizes—½" to ¾".
- **Low Power Consumption:** Continuous Duty Coils rated 10 watts D-C; 10.5 watts A-C.
- **Standard, Watertight or Explosion Proof Solenoid Enclosures:** May be rotated 360° for easy installation.
- **Large flow capacity:** Valve will handle air, gas, water, light oil and other non-corrosive fluids. Available normally closed, valve features teflon disc and stainless steel magnetic parts.

For Pressures to 3000 PSI: Modified designs are available, suitable for handling nitrogen, hydrogen and oxygen at temperatures to minus 350°F. Furnished in ¼" to 1" sizes, valves can be supplied with explosion proof solenoids, and may be designed for operation on 24 volts D-C or other voltages as required.

These all stainless steel valves are especially suited for use on missile ground support equipment.

New! Catalog No. 202 covers the ASCO line of Solenoid Valves. Write for your copy today.

For Immediate Delivery . . .

World's largest stock of Solenoid Valves. A complete Solenoid Valve Stock List will be sent to you with your copy of Catalog No. 202.

Automatic Switch Co.

54-G Hanover Road, Florham Park, New Jersey • FRontier 7-4600

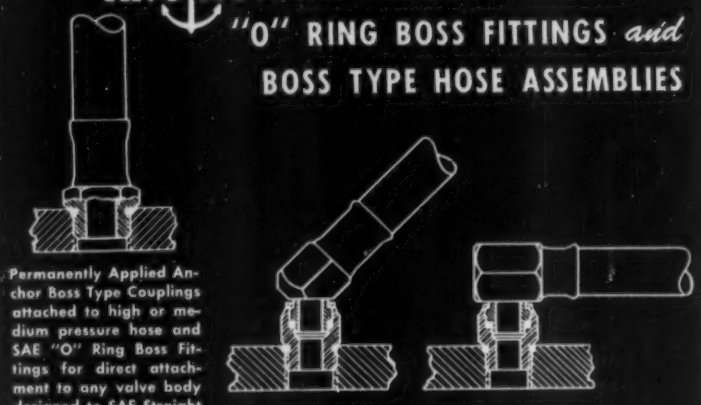
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

For Simpler, More Compact Hook-Ups—

Make them with

ANCHOR® SAE STRAIGHT THREAD "O" RING BOSS FITTINGS *and* BOSS TYPE HOSE ASSEMBLIES



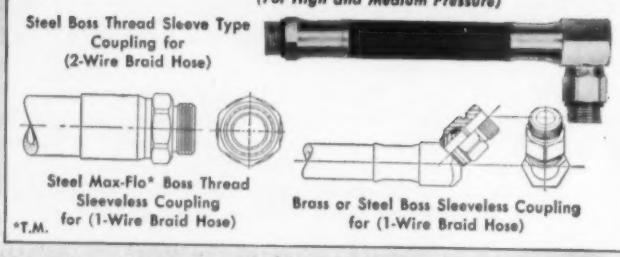
Permanently Applied Anchor Boss Type Couplings attached to high or medium pressure hose and SAE "O" Ring Boss Fittings for direct attachment to any valve body designed to SAE Straight Thread "O" Ring Boss specifications.

A comprehensive line of SAE Straight Thread "O" Ring Boss Fittings for connections.

PLUS

ANCHOR BOSS TYPE HOSE ASSEMBLIES

(For High and Medium Pressure)


Steel Boss Thread Sleeve Type Coupling for (2-Wire Braid Hose)
Steel Max-Flo* Boss Thread Sleeveless Coupling for (1-Wire Braid Hose)
*T.M.
Brass or Steel Boss Sleeveless Coupling for (1-Wire Braid Hose)

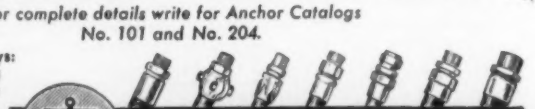
It's amazing what clean, compact hydraulic hook-ups you can make with these Anchor products! You'll appreciate them most when making connections in closely confined areas.

They're neat, orderly and compact always—ready for connection to any valve port designed to SAE Straight Thread "O" Ring Boss specifications.

Excessive tightening is not required with the "O" Ring Seal, eliminating leakage danger from cracked and distorted valve seats and threads, and assuring a leak-proof connection.

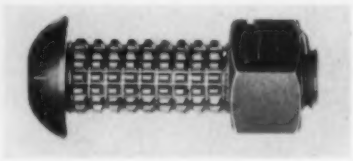
For complete details write for Anchor Catalogs No. 101 and No. 204.

Andy Anchor Says: It's the years of experience that makes every Anchor product a leader of its type.



ANCHOR COUPLING CO. INC.

324 North Fourth St., Libertyville, Ill.
Branch Plants: Dallas, Tex., Plymouth, Mich.



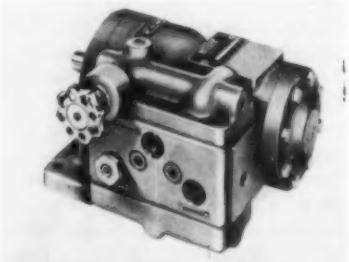
venting packing of material under head. Bolt-rib lengths are sized to accommodate plate thicknesses up to 4 in., preventing riding of steel on bolt threads. Because bolt is preloaded, most or all of structural member load is transmitted some distance from hole, eliminating stress raisers, in hole or from marks created on hole interior by ribs, when joint is put under load. Bolt can be driven in misaligned holes with 3-lb hammer or pulled in with nut. Assembly meets ASTM Spec A-325 or can be furnished hot-dipped galvanized to meet ASTM Spec A-153. Nominal bolt and nut sizes range from $\frac{1}{2}$ to 1 in. dia and are for hole sizes of $\frac{5}{8}$ to $1\frac{1}{16}$ in. Reported to be comparable in price to other high-tensile assemblies. **Automatic Nut Co, Lebanon, Penna.**

Circle 312, Reader Service Card

Offset speed reducer . . .

is shaft-mounted making possible mounting of motor in fixed position and elimination of auxiliary motor rails or slots for belt tensioning. Reducer mounts on shaft by split, tapered bushing. Adjustable torque arms rotate double-reduction unit about input shaft, which is offset from output hub, increasing or decreasing center distance between belt pulleys. Available in reduction ratios of 13:1 and 20:1 and six capacities to handle fhp to 40 hp drives Driven through short centered V-belt drive by any motor. Specifically for OEM slow-speed machinery applications, reducer requires only standard shaft extension of driven machine. **American Pulley Co, 4214 Wissahickon Ave, Philadelphia.**

Circle 313, Reader Service Card



Two-volume pump . . .

requires only single pressure setting for unloading and max pressure. Prevents excessive heat generation and wasted horse-

(Continued on page 84)

AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

A VITAL 100 MINUTES!

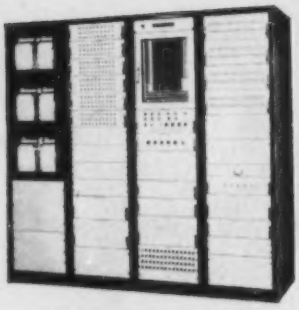
Firing Sequencer with 762 CLARE RELAYS gives automatic control

Automatic control of the countdown at the Air Force's Cape Canaveral Missile Test Center—from X minus 90 minutes to 10 minutes after a missile is fired—is in the hands of a Milgo Model III Sequencer.

The Sequencer, built by Milgo Electronic Corporation, Miami, Fla., automatically controls the myriad operations which must be performed before any missile can be launched. It is preprogrammed to recognize the precise condition that must exist during each of the operations it controls. When any other condition is detected, it will automatically hold fire until the condition is corrected. In a recent instance, it saved a Titan prototype which developed a malfunction after firing but before actual takeoff.

Another of these sequencers is being built by Milgo for installation at the Pacific Missile Range, Vandenberg Air Force Base, Calif.

Milgo engineers selected 762 Clare Type J and Type HG Relays for this supremely important device, and not one has ever malfunctioned. Here is convincing proof that, where the safety of personnel and of valuable equipment is at stake and the utmost accuracy is demanded, a designer who rides with Clare relays can rest assured that he has chosen wisely and well,—not necessarily the cheapest relays but certainly the very best.



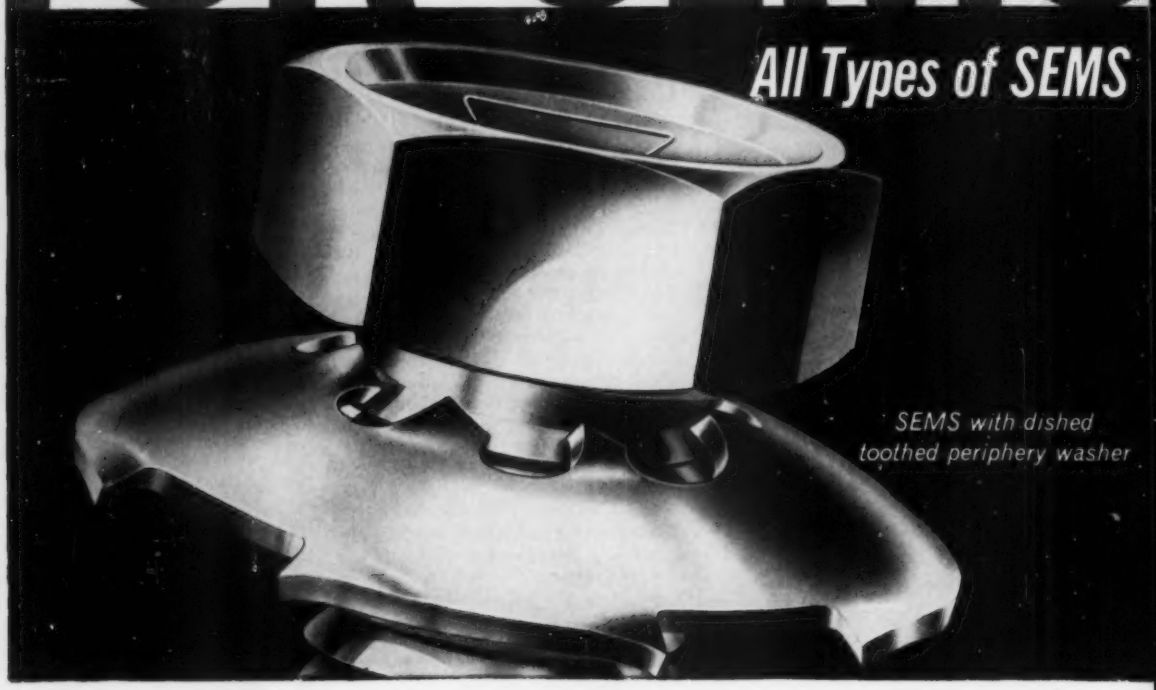
Front view of Model III Sequencer which uses 762 CLARE Type J Relays and 14 CLARE Type HG Relays. Made by Milgo Electronics Co., Miami, Fla.

View of control rack of Model III Sequencer showing 56 CLARE Type J sealed relays.

CLARE RELAYS

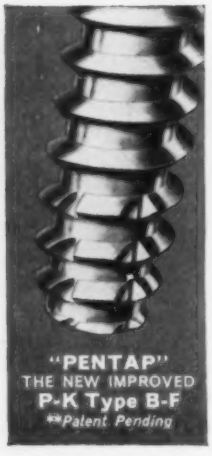
C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.
In Canada: C. P. Clare Canada Ltd., P. O. Box 13[illegible] Downsview, Ontario.
Cable Address: CLARELAY

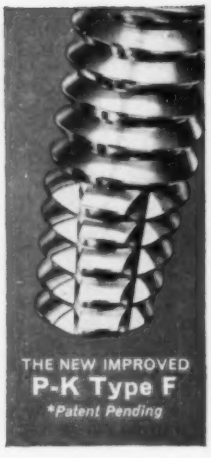
FOR SEMS



3 New, Improved THREAD-CUTTING Screws from P-K

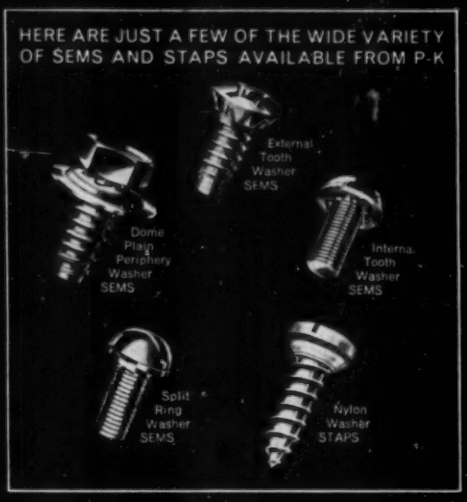
The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving and avoid the possibility of stripping or galling.





...BUY P-K®

and Pre-assembled Fastener-Washer Combinations


HERE ARE JUST A FEW OF THE WIDE VARIETY OF SEMS AND STAPS AVAILABLE FROM P-K
External Tooth Washer SEMS
Dome Plain Periphery Washer SEMS
Interna. Tooth Washer SEMS
Split Ring Washer SEMS
Nylon Washer STAPS

Whatever you require in pre-assembled washers . . . SEMS, and neoprene or nylon washer STAPS® . . . in thread-forming and thread-cutting tapping screws, or machine screws. . . with slotted, Phillips or Hex heads . . . P-K can supply them all through your local P-K "Bulk-Stocking" Distributor.

P-K SEMS reach your assembly line pre-assembled, ready for instant use. Washers cannot come off—can never be mislaid or misplaced—insures washers on the screws . . . not on the floor! Double inventory and double parts handling is completely eliminated.

P-K SEMS can be hopper fed for automatic driving. Inspection rejects due to omitted lock washers are impossible—fastenings stay tight and firm. P-K Sems assure concentric washer seating.

STAPS® are standard P-K fasteners, pre-assembled with nylon or neoprene washers for effective control of leaks, squeaks, crazing and electrolysis, in all types of metal structures and assemblies.

Your nearby P-K "Bulk-Stocking" Distributor can meet your needs—anytime—in any quantity. Call him for samples and complete information.

TYPE F*, the new, improved hardened thread-cutting screws have been developed by P-K for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a standard machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steel, plastics and resin-impregnated plywood.

"PENTAP"**, the new, improved P-K Type B-F (formerly F-Z) combines the five thread-cutting flutes of the Type F screw with the coarse pitch, widely spaced threads of the P-K Type B. The thread-cutting "PENTAP" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.

TYPE L† is a completely new and improved thread-cutting screw developed by Parker-Kalon for use in nylon. The Type L functions as a combination thread-cutting and thread-forming screw . . . in that it cuts a small amount of the nylon to allow the full diameter threads to form. Type L offers a particular advantage in nylon assemblies which must be disassembled for service, because *the P-K Type L can be removed and replaced without stripping or galling.*

FREE test-pak of P-K Sems and Thread-Cutting Screws

Write to P-K today for yours!

PARKER-KALON® fasteners

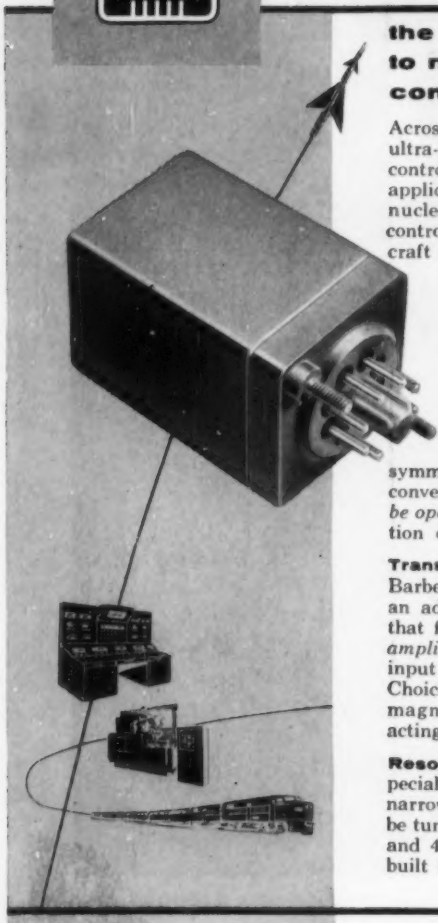
Keep American Industry at Work . . . Buy P-K . . . made in U. S. A.

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey. Offices and warehouses in Chicago and Los Angeles.

THE MARK OF QUALITY

BARBER COLMAN

Ultra-Sensitive Relays



the practical solution to many complex control problems

Across industry today, Barber-Colman ultra-sensitive d-c relays are solving control problems in a wide range of applications such as communications, nucleonics, instrumentation, process control, railway signal transmission, aircraft temperature control and remote positioning systems.

Polarized Micropositioner Relays — The Barber-Colman Micropositioner is an ultra-sensitive polarized d-c relay capable of operating on input powers *as low as 40 microwatts.* Available in three types of adjustment: null-seeking . . . symmetrical magnetic-latching . . . or conventional form C snap-acting. *Can be operated in excess of 100 cps.* Selection of enclosures and mountings.

Transistorized Polar Relays — The Barber-Colman transistorized relay is an adaptation of the Micropositioner that features a *built-in transistor preamplifier,* which greatly reduces the input required for contact operation. Choice of null-seeking . . . symmetrical magnetic-latching, or form C snap-acting contact operation.

Resonant Relays — Characterized especially by low operating power and narrow band width. Standard units can be tuned to any frequency between 115 and 400 cps. Special units have been built to resonate as low as 16⅔ cps.

THE WIDE LINE OF BARBER-COLMAN ELECTRICAL COMPONENTS includes: *D-C Motors* for industrial equipment and aircraft control applications. Output up to 1/10 hp . . . permanent magnet and split series types . . . various mountings and speeds . . . also available with gearheads or blowers. *Tach Generators* for accurate speed indication and servo rate control applications. *Low-cost battery-operated motors. Resonant Relays* characterized by low operating power, narrow band width. *Ultra-Sensitive Polarized Relays* operating on input powers as low as 40 micro-watts. *400 Cycle A-C Motors* for aircraft and missile applications.

TECHNICAL BULLETIN SERVICE on all Barber-Colman electrical components. Detailed specifications, performance data, circuitry drawings. Write for bulletins on any or all products.

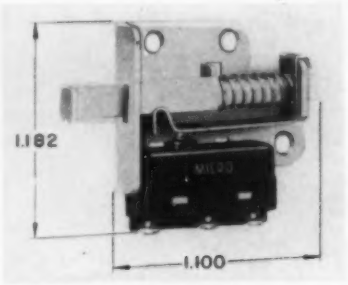
BARBER-COLMAN COMPANY

Dept. S, 1812 Rock Street, Rockford, Illinois

Electrical Components • Small Motors • Automatic Controls • Industrial Instruments
Aircraft Controls • Air Distribution Products • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

power by automatically maintaining system pressure with small-volume pump while fixed differential between relief valve setting and unloading valve allows return of large-volume pump capacity to reservoir at negligible pressure. Unloading response of single-adjustment combination pump is said to be three times faster than previous two-adjustment models. Pressure recovery is reported to be high. Pumps are recommended for 1000 psi at 1200 rpm in small-volume operation and up to 750 psi at 1200 rpm in larger-volume operation. Two pump groups are provided: 18 combinations in small and 30 combinations in large series of pump cartridges, with capacities of 4 to 21.4 and 14.7 to 45.2 gpm, respectively, at max operating pressures for large-volume operation. **Vickers Inc, Detroit 32.**

Circle 314, Reader Service Card



Subminiature door interlock . . .

switch for use on high-voltage cabinets and other electronic cabinets measures 1.182 x 1.5 x 0.35 in. Used to cut off power automatically when cabinet service door is opened. By pulling plunger to maintained contact position, it is possible to check circuits with power on. Plunger automatically returns to normal operation position when door is closed. Total plunger travel is about $\frac{5}{32}$ in. in either direction. High-temperature, snap-action basic switch has SPDT contact arrangement. Electrical rating for 125 or 250 v ac is 5 amp. At 30 v dc, inductive rating is 3 amp at sea level; with resistive load of 5 amp. Max inrush is 24 amp. **Micro Switch, Freeport, Ill.**

Circle 315, Reader Service Card

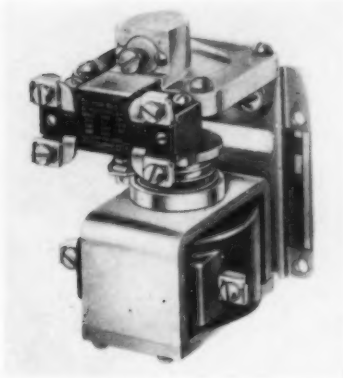
Differential pressure control . . .

for use in areas where explosive gases or vapors are present is offered in five explosionproof models. Several system differentials are available between limits of 30 in. hg and 40 psi, with switch differentials from 0.5 $\pm\frac{1}{16}$ in. hg and up. Control is uncalibrated and pressure settings are made by removing cover and adjusting hex-head adjustment screw. Cast iron enclosure has

(Continued on page 85)

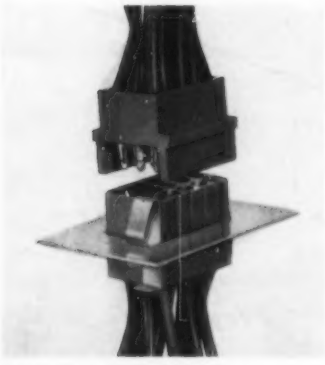
gray enamel finish. Approximate weight, 25 lb. Switch actions include, normally open, normally closed or double throw with no neutral position. Manual reset switches are also available. Single-pole switches are for ambient temperatures to 100 F. Rated 15 or 20 amp, 115 or 230 v ac. **United Electric Controls Co, 85 School St, Watertown 72, Mass.**

Circle 316, Reader Service Card



Pneumatic time-delay relay . . . for dc operation is rated for pilot-duty applications up to 600 v max and provides a timing period adjustable from 0.2 sec to 1 min. Dc timer is a companion unit to ac timer. Both have identical mounting hole dimensions and are available for either on-delay or off-delay operation. Invertible magnet structure permits in-the-field conversion from one form of operation to the other. Timers measure 2$\frac{13}{16}$ x 4$\frac{21}{32}$ in. **Square D Co, 4041 N Richards St, Milwaukee 12.**

Circle 317, Reader Service Card

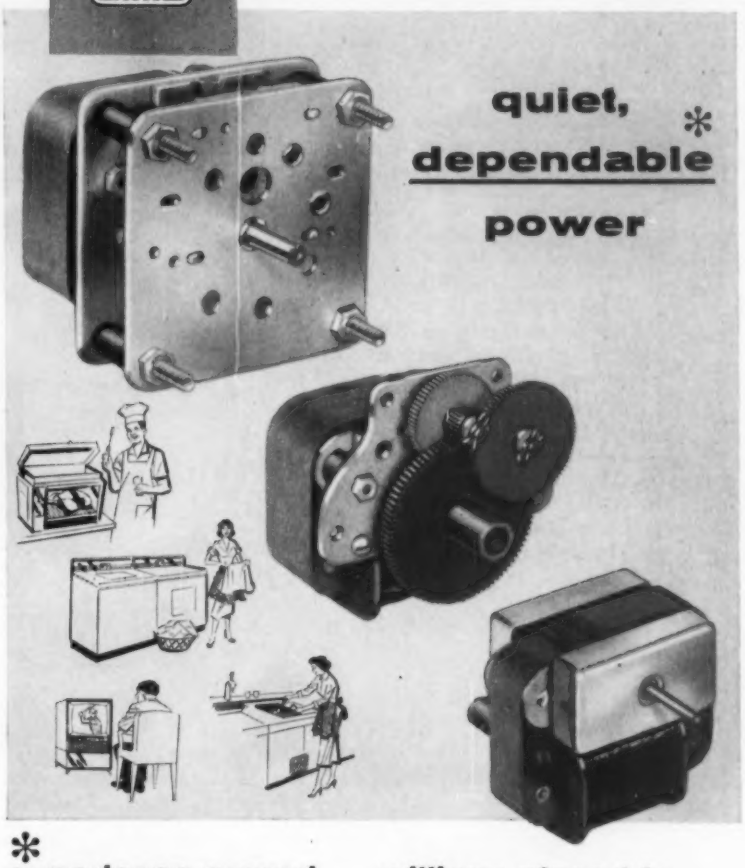


Multiple-circuit plug . . . and receptacle has positive polarity and is offered in up to 60 circuit combinations. Molding method is said to permit custom units at stock unit cost. Terminals are automatically crimped to wires and snap-

(Continued on page 89)

THE MARK OF QUALITY
BARBER COLMAN

a-c small motors



experience-proved . . . millions placed in service by quality appliance makers

Over the years, the extra reliability of Barber-Colman small motors has been proved by the millions of them used in leading appliances. Typical applications of these high-quality, yet low-cost motors include driving blowers and ice cube makers in refrigerators, speed changers in washer-dryers, and door operators of kitchen exhaust fans. Others are found in ice cream freezers, evaporative coolers, water softeners, rotisseries, electric heaters, fans, hair-dryers and the like. Wide selection of unidirectional nongeared and open or enclosed unidirectional geared motors to fit your specific appliance requirements. Write for new a-c small motors catalog.

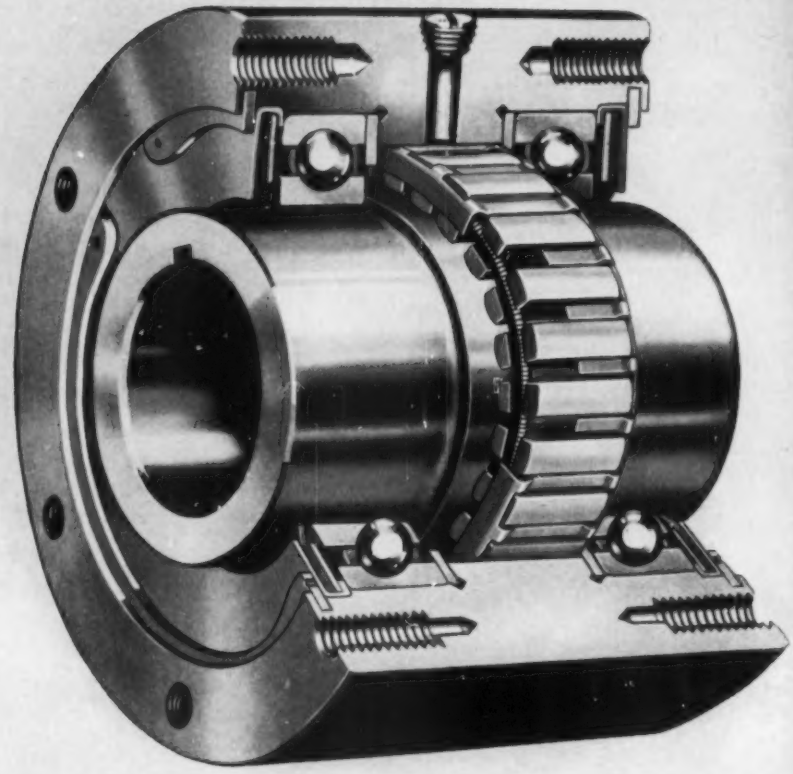
- Low cost
- High starting torque
- Quiet running
- Compact . . . rugged
- Long-life lubrication . . . large oil reservoirs
- Auxiliary oil cups available
- Porous bronze or ball bearings
- Precision-hobbed gears
- Wide range of gear ratios
- Quality guaranteed

BARBER-COLMAN COMPANY
Dept. S, 1212 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls
Electrical Components • Air Distribution Products • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

CIRCLE NO. 85 READER SERVICE CARD 85

NEW! HIGH-PERFORMANCE



This is a high-performance Formsprag clutch having a torque capacity of 475 lbs. ft. and a 1.25″ bore diameter. Note sprag and retainer design that assures coordinated yet free-action movement of sprags. Positive sprag engagement, greater torque capacity, higher speed applications and longer clutch life result from this new design.

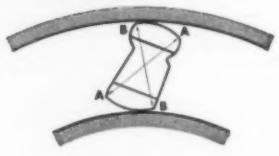
OVER-RUNNING · INDEXING BACKSTOPPING

COMPARATIVE PERFORMANCE CHARACTERISTICS

1. *Longer Life*—Running at identical speeds, an HPO clutch with Formchrome sprags will give you up to 70% longer life than a comparable standard Formsprag over-running clutch.
2. *Increased Speed*—HPO clutches using Formchrome sprags can be operated at up to 30% higher R.P.M. with same life span as a comparable standard Formsprag over-running clutch. Also, the HPO clutch design can be modified for special applications requiring high over-running speeds up to 20,000 R.P.M.
3. *High-Performance Indexing*—Here's a typical example that is characteristic of the entire HPI line. On 15° indexing, a Formsprag HPI clutch with a torque capacity of 475 lbs. ft. can be operated at 1,200 indexes per minute without slip or backlash.

For further information on these High-Performance Over-running and Indexing clutches, send for descriptive brochure.

HERE'S



The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

FORMSPRAG CLUTCHES

FOR OVER-RUNNING · INDEXING

Formsprag clutches have always provided greatest torque for size and weight, higher precision, no measurable backlash and long, trouble-free life. However, designers and users often have applications for over-running and indexing clutches where even higher performance characteristics are required.

To meet this need for super-performance, Formsprag has perfected a new line of High-Performance Over-running (HPO) clutches and a new line of High-Performance Indexing (HPI) clutches.

The HPO and HPI clutches have an improved sprag design and retainers that assure a coordinated movement of all sprags but each sprag also has a free-action feature. The design assures: positive engagement of every sprag—uniform distribution of driving load over all sprags—greater torque capacity for clutch size. This same "Free-Action" operation of sprags also assures there will be a minimum of drag on all sprags during over-running. Result, clutch can operate at higher speeds, there is less wear on all clutch components and longer clutch life is obtained.

There is a Formsprag clutch size and model for every application—from business machines to aircraft. HPO, HPI and standard FS clutches are completely described in a new brochure, write for your copy.

FORMSPRAG COMPANY
23607 Hoover Road, Dept. 103
Warren (Detroit), Michigan

In Canada: Renold Chains Canada, Ltd.
In United Kingdom: Renold Chains Limited
Distributors in Principal Cities.

FORMSPRAG CLUTCHES

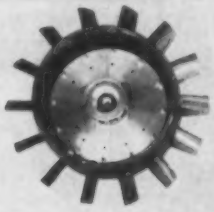
World's Largest Exclusive Manufacturer of Over-running Clutches

HOW IT WORKS

An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

RAWSON FOR NO-LOAD STARTS



The compactness, reliability and maximum capacity of Rawson Clutches have proven especially effective in aircraft applications such as helicopter transmissions. Used in a wide variety of other applications, Rawson Clutches eliminate costly reduced voltage starting equipment, permit use of lower cost smaller motors and provide full overload protection. Write for your copy of Rawson Clutch Catalog.

CIRCLE NO. 87 READER SERVICE CARD 87

STANDARD HOSES

LOW PRESSURE	H-9 SAE 30R2	H-100 COTTON COVERED
MEDIUM PRESSURE	H-17 SAE 100R3	
HIGH PRESSURE	H-25 SAE 100R2	
MEDIUM HIGH PRESSURE	H-69 SAE 100R5	
MEDIUM HIGH PRESSURE	H-108 SAE 100R1	
HIGH PRESSURE	H-35	H-50

Spiral Wire Reinforced

REUSABLE ENDS

STEEL

STANDARD 2-PC. END

For fast assembly and positive, leakproof connections. Designed for dependable performance under high pressure. Skive and no-skive.

CLAMP-TYPE

For most two-wire braid high-pressure hydraulic hose applications. No skiving of hose or special tools required.

BARB-TITE ENDS

Fast, easy push-on, stay-on hose ends for all types of low pressure applications. Sizes ¼" to ¾" I.D. Rugged and durable.

HOSE ASSEMBLIES

PERMANENTLY ATTACHED HOSE ENDS

Swaged or crimped permanently attached hose ends. Any quantity, any size, any type. ⅛" to 2". For all working pressures.

CRIMPED

SWAGED

TUBE-HOSE ASSEMBLIES

THE WEATHERHEAD COMPANY

FORT WAYNE DIVISION • Dept. PE-7, 128 West Washington Blvd.
Fort Wayne, Indiana

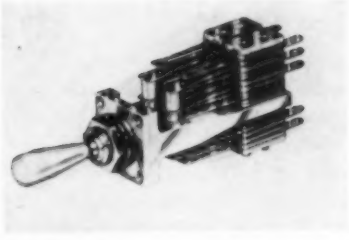
lock into male and female units. They are removed with ejector tool. Skirt on plug serves as both terminal protector and positive polarity. Snap clips permit easy mounting and removal for panel installations. Reported to have excellent electrical and physical properties. Suitable for appliances, electronics and other multiple circuit installations. Units are made of bakelite. Unit for 15 circuits measures 1 1/16 x 3/4 in. Rated 6½ amp per connection, for 125 or 250 v ac. **Molex Products Co, 9515 Southview Ave, Brookfield, Ill.**

Circle 318, Reader Service Card

Magnetic clutches, brakes . . .

are part of line encompassing nine models in five frame sizes. Line is said to have highest torque ratings in field ranging from 6 in.-oz (size 5) to 224 in.-oz (size 18) with power consumption ranging from 2.5 to 5 w, respectively. Magnetic design is such that it is said not to load bearings, resulting in low breakaway torque and long life. Features high precision in concentricity and size of shafts and pilot diameters, and fast response time. Meets all applicable military environmental tests. May be wound with Teflon for performance under Class H temperatures. Clutches and brakes are for use in servo and control systems, analog computers and precision instruments. **Dynamic Instrument Corp, 59 New York Ave, Westbury, NY.**

Circle 319, Reader Service Card



Single-hole lever switch . . .

has independent detent mechanism. Overall length is 3 5/16 in. and extends 2¼ in. behind panel. Capacity is up to 40 contact springs in any combination of four basic contact forms, A, B, C or D. Mounts on ¾-in. centers with ⅜-in. threaded bushing, has aluminum frame and is available with bifurcated contacts. **Donald P Mossman Inc, Brewster, NY.**

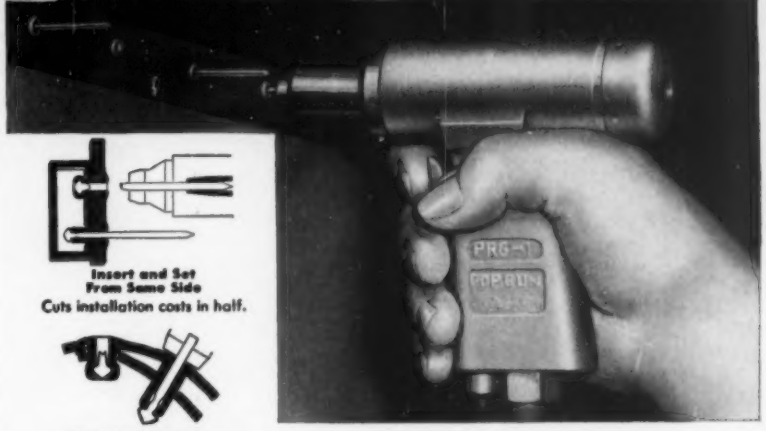
Circle 320, Reader Service Card

Wire-mesh filter elements . . .

assemblies are for service from 0 to 5000 psi and from –65 to 275 F. Ultrafine mesh is made rigid by process that bonds

(Continued on page 92)

"POP" RIVETS



Insert and Set From Same Side
Cuts installation costs in half.

High Clinching Action
Pulls parts together with up to 600 lbs. squeeze. Eliminates need to clamp.

Wide Grip Range
Simplifies inventory, purchasing, inspection. Same length "POP" Rivet holds tight through thick or thin.

Vibration Proof
"POP" Rivets cannot back out or become loose. Ensures tight assembly for years of use.

Low Head Profile
Where space is important, "POP" Rivets' minimum head height eliminates clearance problems and improves appearance.

Least Back-Up Space
Strong, high strength "POP" Rivets need only enough back-up space to provide room for set head. Gives more compact design.

- **Cut Assembly Costs**
- **Solve Design Problems**
- **Installed and set from same side**

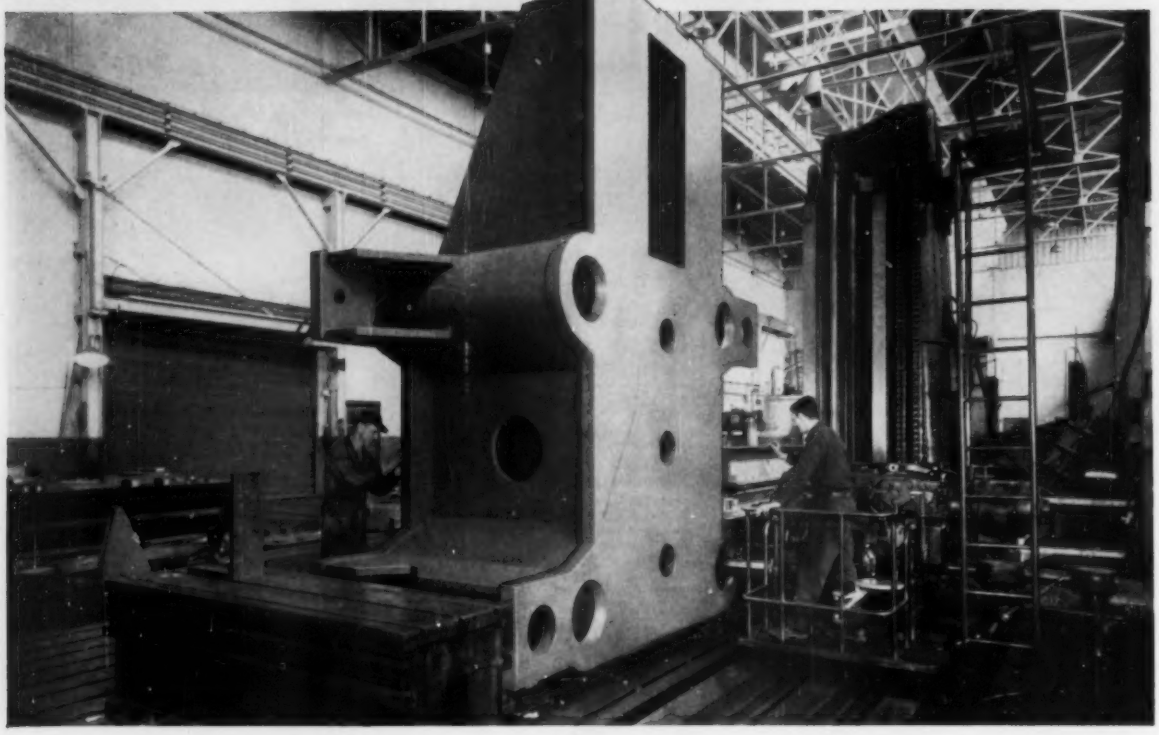
"POP"® Rivets cut *installed fastener costs*, add design flexibility, and increase assembly convenience because they are inserted and set from the same side. Up to 1200 can be set per hour right on the assembly line — even by an unskilled operator.

"POP" Rivets are precision made, hollow rivets assembled on a solid high tensile mandrel. The setting tool pulls the mandrel head into the rivet from the front side, setting the rivet on the reverse side. Mandrel breaks under tension of up to 1600 lbs. and falls free.

You can cut installed costs, increase assembly convenience, and secure high speed, trouble-free fastening immediately with "POP" Rivets. No need for complicated or extensive re-tooling. Simplify product design, cut handling time. Call or write us today — now — and start cutting your *installed fastener costs* with "POP" Rivets! Or better still, send us a sample assembly for riveting.

"POP" Rivet Division
UNITED SHOE MACHINERY CORPORATION
Shelton, Conn., Regent 5-3391

STEEL-WELD FABRICATION . . .



PRECISION WELDMENTS

Fabricated and Machined to Specification!

The 40-Ton Press Bed, undergoing machining operations above, is typical of Mahon workmanship and capabilities in this field. It is one of thousands of Steel-Weld Fabricated parts and assemblies produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment.

When your design calls for weldments of any kind, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information on Facilities, or have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

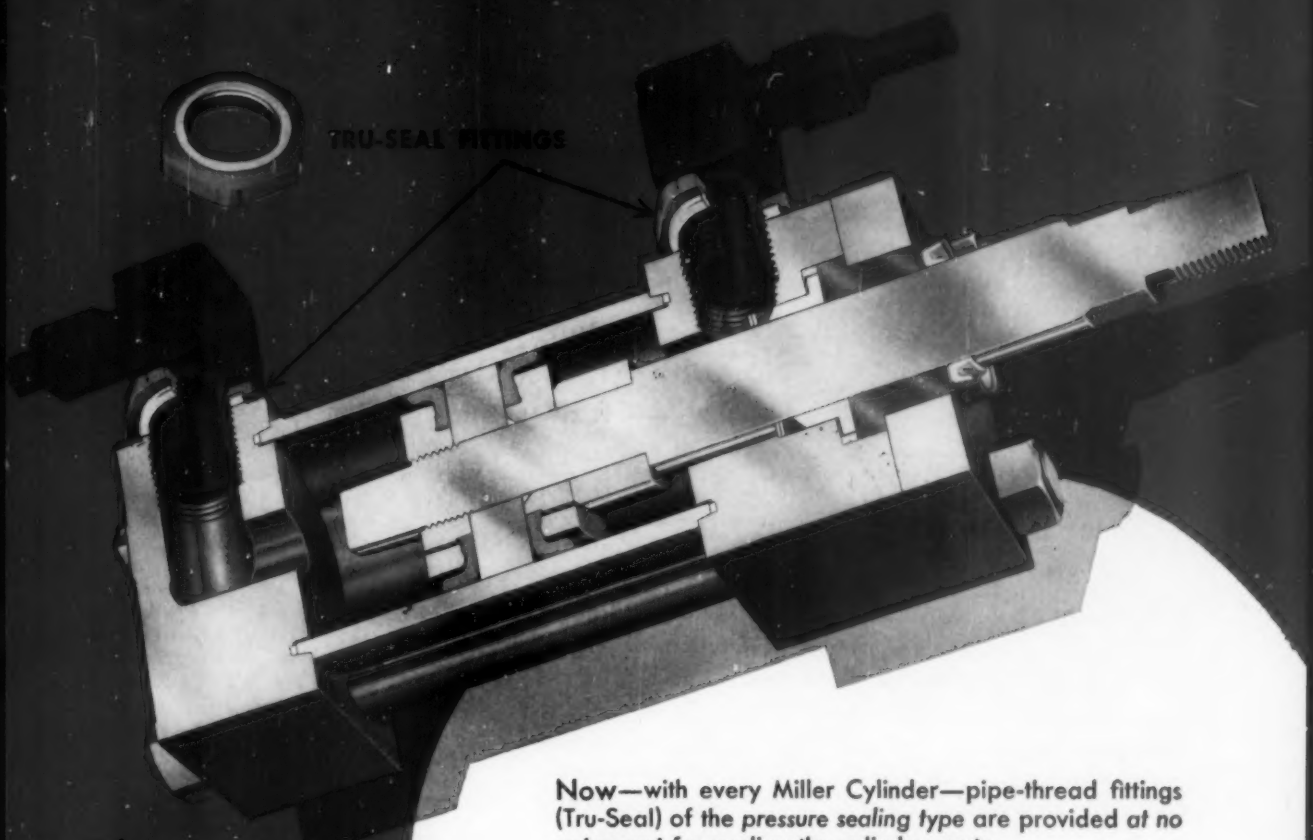
SALES-ENGINEERING OFFICES in DETROIT, NEW YORK, CHICAGO and LOS ANGELES

Use WELDED STEEL for 100% Predictability and Greater Strength with Reduced Weight!

MAHON

NOW...even the PORTS have seals of the PRESSURE SEALING TYPE!

J.I.C. Standard H6.2.21

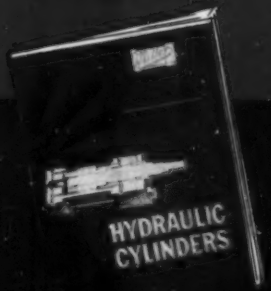


Now—with every Miller Cylinder—pipe-thread fittings (Tru-Seal) of the *pressure sealing type* are provided *at no extra cost* for sealing the cylinder ports.

Additional advantages of these fittings are:

1. All circuit piping and fittings can be easily positioned.
2. Damage to equipment caused by high tightening torque is completely eliminated (especially on valves, pumps, etc.)
3. Sealing material is Teflon, which is compatible with all hydraulic fluids (J. I. C. Standard H6.2.1)

Specify Miller For Greater Reliability



Engineering Bulletins on Miller Air and Hydraulic Cylinders Available on Request

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION

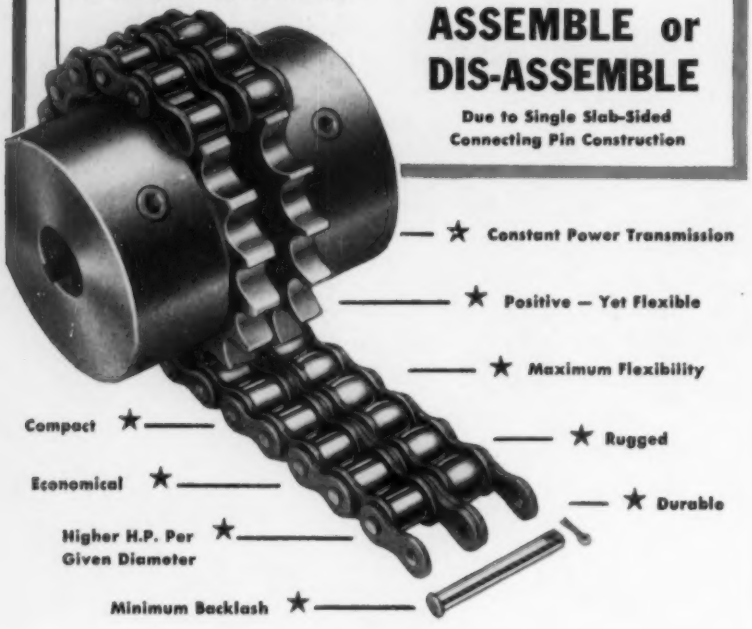
7N018 YORK ROAD, BENSENVILLE, ILLINOIS

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Here's the Easiest FLEXIBLE COUPLING to ASSEMBLE or DIS-ASSEMBLE

★ All Teeth Hardened — Hubs and Bores Remain Soft to Permit Reworking. Also Available in Finished Bores including Keyway and Setscrew.

Due to Single Slab-Sided Connecting Pin Construction



★ Constant Power Transmission

★ Positive — Yet Flexible

★ Maximum Flexibility

Compact ★

★ Rugged

Economical ★

★ Durable

Higher H.P. Per Given Diameter ★

Minimum Backlash ★

Acme Flexible Couplings are quickly assembled or dis-assembled by means of a chain that has only one pin to connect or remove. Connecting links are permanently positioned on chain to engage connecting pin without difficulty in assembly. Positive Power Transmission is assured, with provisions for both angular and parallel misalignment. They absorb shock loads, provide maximum flexibility with minimum backlash. All steel construction to give maximum life expectancy. You save money in the *long run.*

Acme Flexible Couplings and Roller Chains are available nationally through your local Industrial Distributor. Be sure to specify ACME.

Write Dept. 1-F, for Special Catalog CPI-57 on Flexible Couplings.

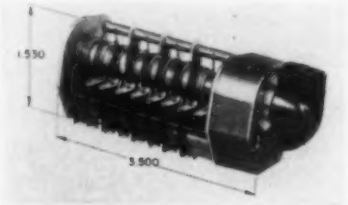
Call ACME for Service

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

cross wires to each other and fabricates them into high area corrugated construction with positive maximum-particle-passed control. Reusable stainless filter elements are offered for 98% removal ratings of 2, 5 and 10 micron-size particles. Assemblies are offered with no relief valve and with element reinforced to withstand 4500-psi differential pressure. Suitable for hydraulic fluids, lubricating oils, fuels, air and helium. **Aircraft Porous Media Inc, 30 Sea Cliff Ave, Glen Cove, NY.**

Circle 321, Reader Service Card



Rotary selector switch . . .

assemblies have cock-and-fire actuating mechanism that moves positively from one position to another. Said to prevent circuit tease or actuator hang-up between 90° detents. Individual actuating levers pivot on common rod, and levers are operated by precision cams that are rigidly mounted on actuator shaft in desired sequence of operation. Can be provided with 2 to 8 basic switches and 2 or 3 actuator positions. Assemblies require less than 1¾-in. dia of panel mounting space. Ring seal on operating shaft keeps moisture out of actuating mechanism. Switches operate in temperature of –65 to 250F. Rated for 125 or 250 v ac, 5 amp or 30 v dc. Each basic switch has SPDT contact arrangement. **Micro Switch, Freeport, Ill.**

Circle 322, Reader Service Card

Semiconductor alloy kit . . .

includes 24 different alloys in various usable forms such as disks, spheres and washers, in excess of 25,000 preforms. Kit can be used to speed development of new devices and processes without delays, and setup costs previously encountered in procuring small lots. All alloys are packaged in argon for maximum shelf life, and documented so they can be reproduced at a later time to meet production quantities. Kit is priced at $100. **Accurate Specialties Co Inc, 37-11 57th St. Woodside 77. NY.**

Circle 323, Reader Service Card

Riveting kit . . .

for developing methods of joining similar or dissimilar metals in blind or restricted areas consists of hinged-cover container with six individual, transparent polystyrene

(Continued on page 95)

you get the RIGHT Motor...

for your power-driven product with

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

You get the *right* motor to assure the product performance desired...

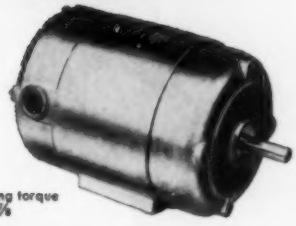
You get the *right* motor to meet weight and space requirements...

You get the *right* motor cost-wise, too, because...

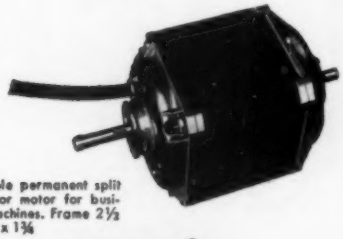
Lamb Electric motors are *engineered* to the application and *mass-produced* to obtain the most favorable cost.

May we demonstrate these advantages of our nearly half-century of experience in the small motor field?

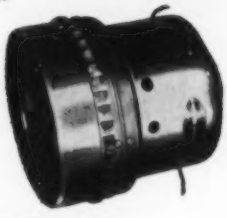
THE LAMB ELECTRIC COMPANY
Kent, Ohio
A Division of American Machine and Metals, Inc.
In Canada: Lamb Electric
Division of Sangamo Company Ltd.—Leaside, Ontario



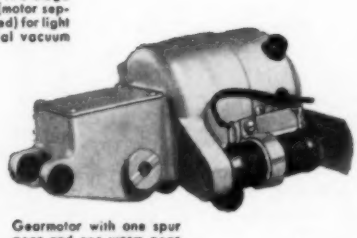
Elevator door operating torque motor. Frame 3⅝ x 1⅞



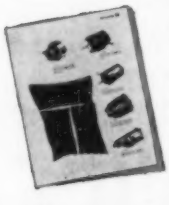
Four-pole permanent split capacitor motor for business machines. Frame 2½ square x 1¾



⅝ Horsepower two-stage "by-pass" unit (motor separately ventilated) for light duty commercial vacuum cleaners.

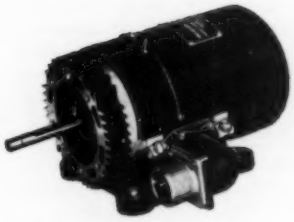


Gearmotor with one spur gear and one worm gear stage giving right angle drive for business machines. Frame 3⅝ x 1⅞



NEW!

8-page Folder describes these and other Lamb motors. Send for your copy.



Totally enclosed fan-cooled 27 volt DC motor for dry air pump drive. Frame 3¼ x 1⅝

Two-pole 60 cycle AC motor incorporating propeller fan and high speed blower driven through step-up gear train. Frame 4½ x 1¼

CIRCLE NO. 93 READER SERVICE CARD 93

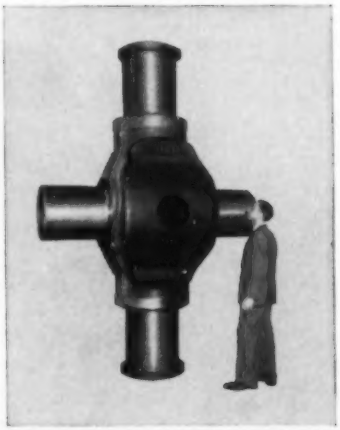
Blaw-Knox Steel Foundries have the heat treating capacity to handle the largest casting

Your steel casting gets precisely the characteristics of uniform hardness, toughness, or temper you specify in a Blaw-Knox Steel Foundry. Blaw-Knox Steel Foundries are equipped with huge pit-type furnaces—some as large as 42 feet × 20 feet × 13 feet deep, and banks of car type furnaces to accommodate the largest steel casting or batches of smaller ones.

Quench tanks as large as 21 feet × 12 feet and 8 feet deep are available, and all Blaw-Knox Steel Foundries are equipped for spray quenching in which specific areas of steel castings are given special quenching. Further flame hardening or other hardening procedures are provided to meet your exact requirements.

Complete heat treating, quenching, and hardening is another way in which Blaw-Knox Steel Casting Service adds value to your product. Blaw-Knox, as one of the world's leading rolling mill and industrial machinery builders, keeps a sharp eye on the end-use requirements of a casting from start to finish. It's your assurance of a component of the highest quality, made for maximum service.

If you design or build products using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like you to have a copy of our brochure detailing Blaw-Knox Steel Castings Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania. No obligation of course.



This main axle casting for the 60-cubic yard Mountaineer Shovel was cast in a Blaw-Knox Steel Foundry. Wt.—18,000 lbs.

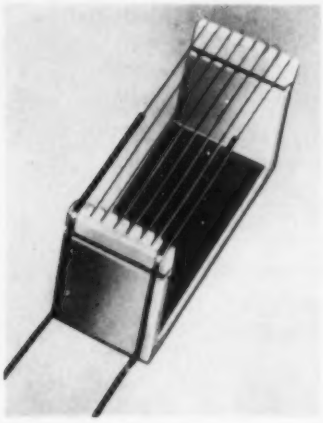
BLAW-KNOX **STEEL CASTING SERVICE**

CIRCLE NO. 94 READER SERVICE CARD

New Parts and Materials.....continued

boxes, each having 40 rivets in $\frac{1}{8}$ in. dia for panel thicknesses to $\frac{1}{4}$ in. in steel, aluminum and combinations of these. Also contains hand tool. **Pop Rivet Div, United Shoe Machinery Corp, Shelton, Conn.**

Circle 324, Reader Service Card



Flat-grid strain gage . . . elements can be cemented directly onto specimens without intervening paper or bakelite, increasing stability and sensitivity and lessening creep. Temperature-operating range is limited only by cements used. With suitable cements, gages are reported to have withstood up to 1200 F. Bare grid is formed by winding small-diameter wire into evenly-spaced grooves on ceramic insulators. Grid wire is spotwelded to ribbon-type lead wires. Available in sizes from $\frac{1}{8}$ x $\frac{1}{8}$ up, and with resistances of 120 to 500 ohm. Illustration shows strain gage attached to frame, which is detached after gage has been applied to specimen. **Waldale Research Co Inc, 362 W Colorado Blvd, Pasadena, Calif.**

Circle 325, Reader Service Card

Hydraulic tensile tester . . . can be converted to compression tests by user with regular hand tools. A $\frac{1}{6}$-hp motor and small hydraulic pump supply pressure to hydraulic cylinder located behind hydraulic load-gage at top of tester. Capacity of vertical bench-mounted tester is reported to be 10,000 lb. Accommodates lengths up to 7 in. Motor is wired for 110-v, single-phase, 60-cps ac operation. Additional sizes of flat jaws, three sizes of round jaws, compression plates and special gripping devices are available. $\frac{1}{2}$ in. thick x 1 in. wide is max accepted size for flat specimens. Cylindrical specimens up to $\frac{3}{4}$ in. dia can be tested. Base dimensions are $11\frac{1}{2}$ in. sq and over-all height is 44 in. **Steel City Testing Machines Inc, 8817 Lyndon Ave, Detroit 38.**

Circle 326, Reader Service Card

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66DD.

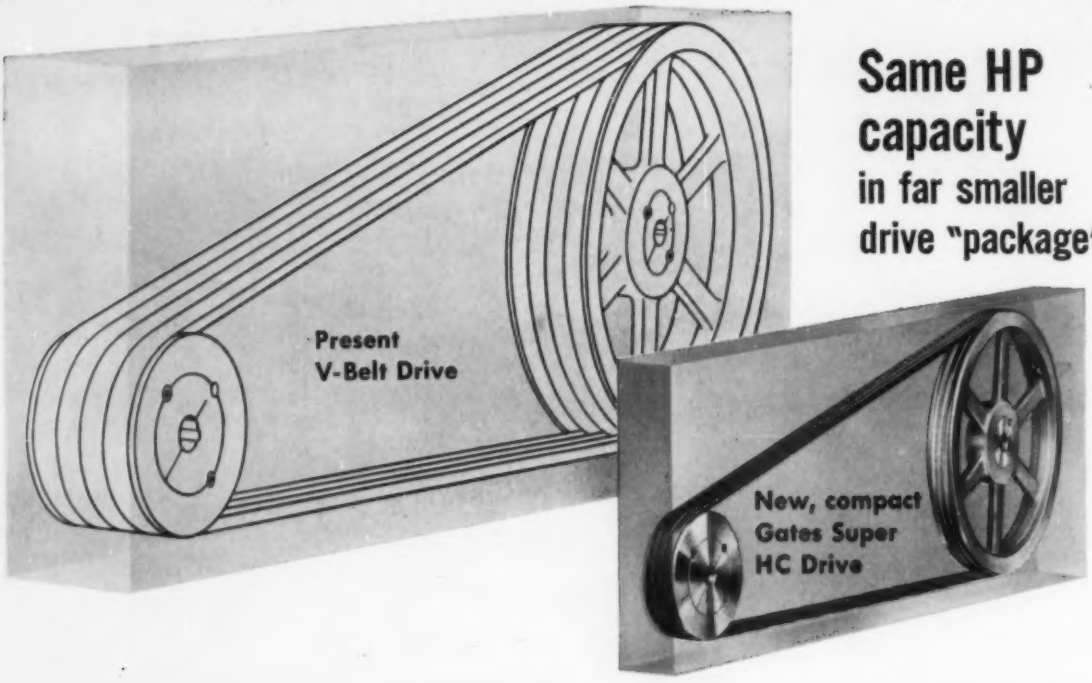
DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric



Same HP capacity in far smaller drive "package"

New high capacity Gates V-Belt cuts drive space, weight and cost

Reduce size, cut costs! Gates new Super HC V-Belt puts power transmission in a smaller package—cuts costs all along the line!

Actually, this major advance in power transmission—a development of *specialized* research in the world's largest V-belt laboratories at Gates—makes possible the most compact, lightest-weight, lowest-cost multiple V-belt drive you can put on any machine. Sheave diameters can be reduced up to 50%, sheave widths 30% to 50%, center distances 20% and more.

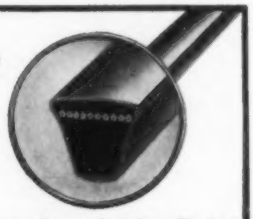
Reduce drive cost as much as 20%

On new drives, the cost of a Gates Super HC V-Belt Drive is as much as 20% under the cost of present V-belt drives of the same hp capacity. Furthermore, smaller housings and bases—less materials, production time, shipping costs all reduce costs still further.

Learn more about the cost-saving Super HC Drive

"The Modern Way to Design Multiple V-Belt Drives" is an informative handbook on the Super HC Drive, available from your nearby Gates Distributor listed in the Yellow Pages under Belts or Belting.

The Super HC V-Belt



transmits same HP in much less space than belts now in use

Shown below are space savings of a typical installation:

	Drive R Sheave Diam.	Drive N Sheave Diam.	Center Distance	No. of Belts
Present Drive	7.4"	20.0"	42.9"	4
Super HC Drive	**5.3"**	**14.0"**	**30.0"**	**3**

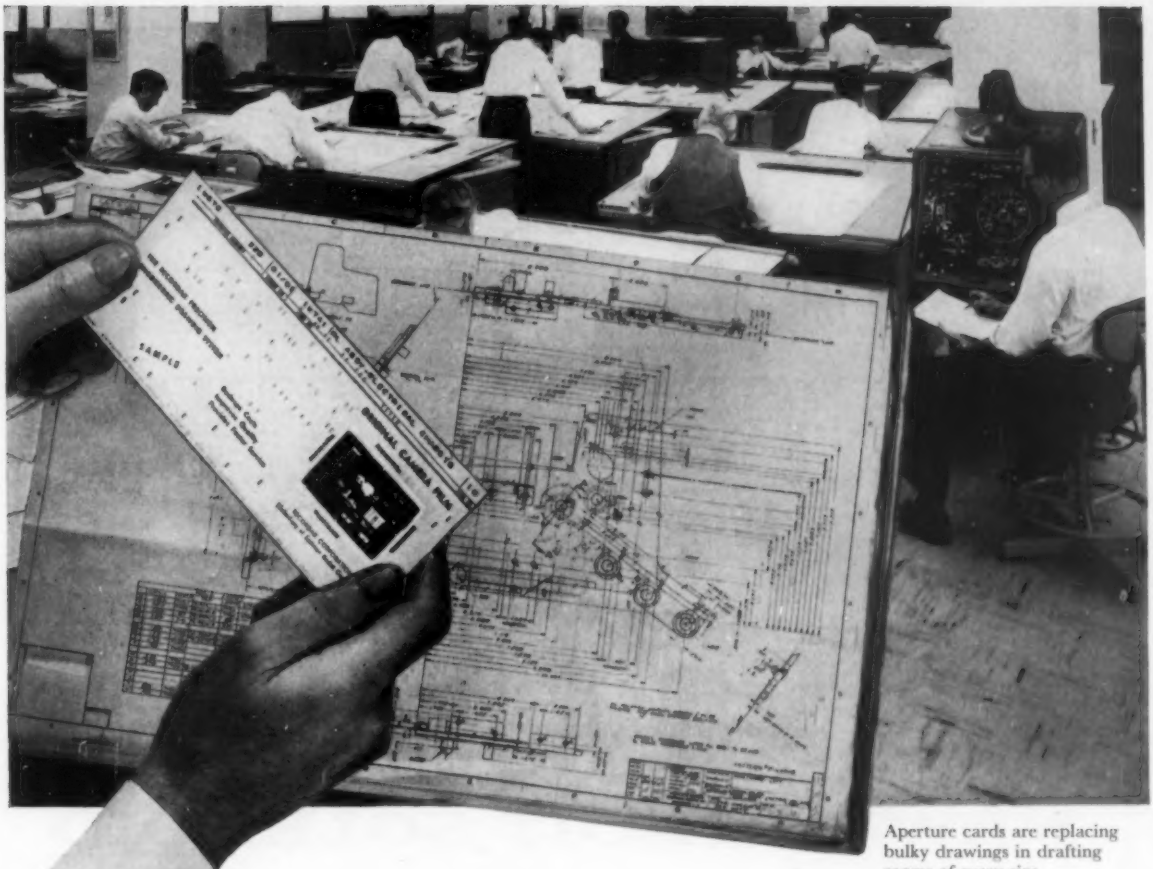
TPA 423

Gates

World's Largest Maker of V-Belts

The Gates Rubber Company • Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates Super HC V-Belt Drives



Aperture cards are replacing bulky drawings in drafting rooms of every size

First step in automating your drawing file:

Sharp, legible pictures on low-cost 35mm Recordak Microfilm

When you automate your engineering drawings—when you turn these bulky records into trim decks of cards—you can count on: 1) Faster reference and communications; 2) Lower blueprint costs; 3) Savings in filing space and equipment; 4) Greater protection.

Your success with this new system depends, first, upon the quality of your microfilm reproductions. They must be completely legible when viewed in film readers; they must also produce accurate, easy-to-read paper prints when needed.

Using the Recordak Precision System, you are assured that your films easily pass the most rigid requirements. For Recordak pioneered the job of reproducing engineering drawings on low-cost 35mm microfilm. Developed controls and standards which assure that drawings and prints of all ages, sizes and colors, are reproduced with remarkable clarity and uniformity.

So step into "automation" with full confidence! Call your local Recordak office or Recordak Microfilming Dealer. No obligation. *"Recordak" is a trademark*

RECORDAK

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming—

now in its 32nd year

.....MAIL COUPON TODAY.....

RECORDAK CORPORATION EE-7
415 Madison Avenue, New York 17, N. Y.

Gentlemen: Send free booklet describing new Recordak Precision Engineering Drawing System. No obligation whatsoever.

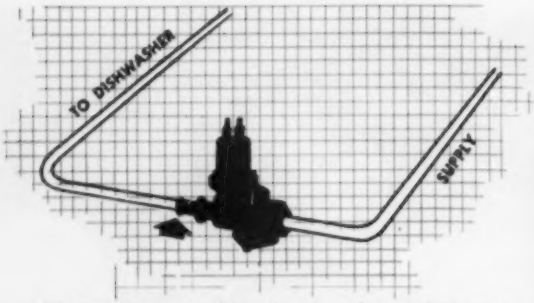
Name_____

Company_____

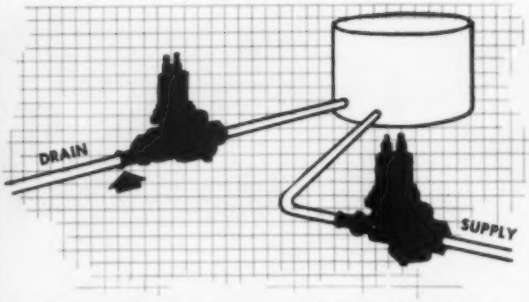
Position_____

Address_____

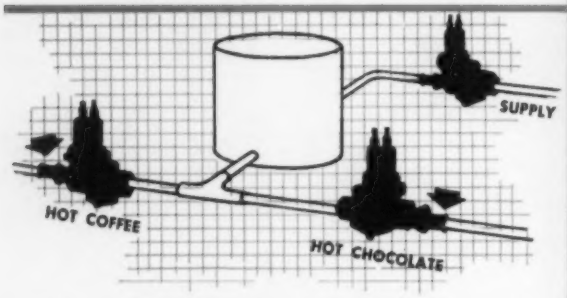
City_____ State_____



Hot water enters a dishwasher several times during its wash-rinse cycle. The control? Detroit Controls' S-25 Solenoid valve.



An automatic water softener recharges itself. The S-25 valve and a timer simplifies the regeneration process.

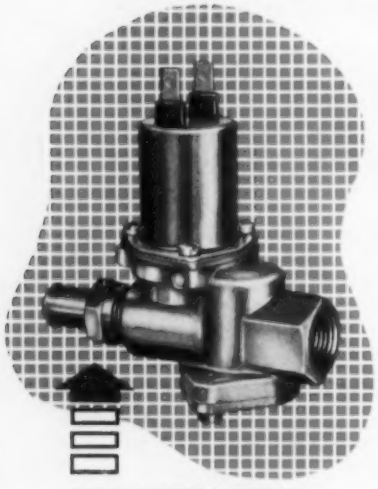


Put a dime in a vending machine. You get your choice of hot coffee or hot chocolate. There's an S-25 controlling the hot water to each—still another controlling the master supply entering the machine.

IT'S YOUR TURN! Doodle your own piping arrangement here. It's dollars to doughnuts that if you have a varying water flow control problem, the S-25 will help you do a better job.

NEW DETROIT SOLENOID
GIVES CONSTANT WATER FLOW

from 1/4 to 6 gpm—2-1/2 to 200 psi—up to 180°F
(Up to 200° For Special Applications)



FLOW CONTROL DEVICE IS LOCATED HERE.

Here's a new valve that will positively open — positively close — time after time after time. Detroit has designed it with flexibility in mind. For example, the flow control device in the outlet connection assures accurate delivery of water quantity regardless of varying supply pressures. It also is available with any of three different connections: pipe, tubing or hose. The S-25's unique construction permits accurate volume control when mounted in any position. There is a wide variety of brackets available. It has a large, integral, easy-to-get-at, easy-to-clean strainer and features waterproof, interchangeable coils for all standard AC voltages. Available with top or side spade terminals or pigtails. It's listed by the Underwriters' Laboratories.

* * *

We know of the three applications above and we'd like to know about yours. Sketch where this valve could fit into your system. Mail it to us and we'll shoot a quote right back to you. Or if you wish, we'll send a Detroit representative out right away. Just write to Detroit Controls Division of American-Standard, 5900 Trumbull Ave., Detroit 8, Michigan.

American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
DETROIT CONTROLS DIVISION

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 114

SKEW-AXIS GEARS—Manual, 36 pp. Contains information to determine basic design requirements such as ratings, selections, center distances, bearing loads and mounting methods. With photos and drawings to illustrate principle and application of gearing system for medium to high reduction ratios. Spiroid Div, Illinois Tool Works, 2501 N Keeler Ave, Chicago 39.

Circle 331, Reader Service Card

ELECTRICAL, ELECTRONIC COMPONENTS—Catalog 30, 32 pp. Lists dimensions, ratings and prices of stock components. With photos and dimensional drawings. Includes rheostats, potentiometers, resistors, relays, variable transformers, tap switches, chokes, capacitors and miscellaneous components. Ohmite Mfg Co, 3630 Howard St, Skokie, Ill.

Circle 332, Reader Service Card

STORAGE BATTERIES—Booklet, 32 pp. Discusses storage battery, electrical system, battery chemistry and construction. Also tells how to prevent corrosion, how to buy batteries, how to test batteries, how to recharge batteries, how to install and remove batteries, how to fill dry charged batteries and how to store batteries. Exide Automotive Div, Electric Storage Battery Co, PO Box WK 6266, Cleveland 1.

Circle 333, Reader Service Card

COBALT-NICKEL SPRING ALLOY—Handbook, 26 pp. Describes properties of alloy, which include corrosion resistance, high resistance to set, and fatigue and non-magnetic qualities. Contains tables and performance graphs showing mechanical properties of alloy in strip, wire and rod form. Elgin National Watch Co, Elgin, Ill.

Circle 334, Reader Service Card

HIGH-SPEED INDEXING—Catalog 108, 24 pp. Data on high-speed, precision, roller gear-drive indexing mechanisms for achieving intermittent and oscillating motions. Stock and standard components and housed units are shown, as well as power assemblies, standard right-angle drives and gear reducers. Information for calculating load requirements and designing an installation is provided. Also cataloged are load rating and dimensions of standard index tables and rotary transfer machine bases. Ferguson Machine Corp of Indiana, 7818 Maplewood Industrial Ct, St Louis 17.

Circle 335, Reader Service Card

BUTYL CABLE—Catalog 102, 32 pp. Contains information on design features, insulations available and performance highlights of butyl-rubber power cable. Also includes data on available constructions from 600 to 15,000-v conductors. Anaconda Wire & Cable Co, Dept EFL, 25 Broadway, New York 4.

Circle 336, Reader Service Card

PHOTOELECTRIC CONTROLS—Bulletin GEA-6822, 16 pp. Describes line of controls for industrial counting, sorting, signaling, protecting, diverting, detecting and limiting applications. Includes specifications and prices. Illustrates how devices can be applied. General Electric Co, Schenectady 5.

Circle 337, Reader Service Card

INDUSTRIAL LIMIT-SWITCH APPLICATIONS—Booklet, 9 pp. Suggestions for proper application of industrial limit switches are illustrated, with notations. Reprinted from NEMA Publication 1C3-1959. Micro Switch, Freeport, Ill.

Circle 338, Reader Service Card

TUBE FITTINGS—Catalog, 20 pp. Contains information on O-ring seal tube fittings, flare fittings, pipe fittings, tube benders and other hydraulic components. With flow charts, JIC piping data and design information. Lenz Co, Box 1044, Dayton 1, Ohio.

Circle 339, Reader Service Card

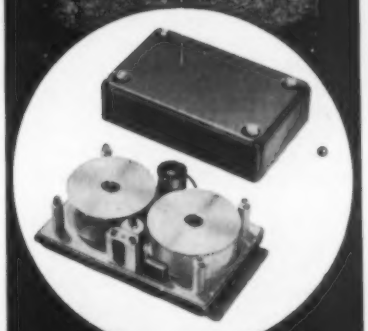
INTEGRAL TUBING SHEETS—Brochure, 8 pp. Describes procedure for putting tubing pattern on sheet, gives dimensional information and illustrates typical examples of applications. Western Brass Mills Div, Olin Mathieson Chemical Corp, East Alton, Ill.

Circle 340, Reader Service Card

STAINLESS TUBING, PIPE AND WELDING FITTINGS—Technical data card TDC-192, 2 pp. Gives high-tem-

(Continued on page 102)

NEW!
BEATTIE-COLEMAN PROGRAMER
...provides
4 to 2
HOUR PROGRAM
on 13 channels



160 feet of punched Mylar tape is accommodated in the new Beattie-Coleman MLPR-13 Programer, providing a completely random program of 252 minutes duration on 13 channels. Extremely accurate time control with no cumulative error. Available in five speeds: 3/16", 3/8", 3/4", 1 1/2", and 3" per sec. Weighs less than 5 lbs., is easily removable for loading. Programs can be initiated or altered in a few minutes. Compatible with most missile guidance systems.

Write for complete data on the MLPR-13 and other multi-channel Beattie-Coleman Programers for either repeat cycling or random operation.

BC BEATTIE-COLEMAN inc.

1000 N. Olive St., Anaheim, California
Branch: 437 Fifth Avenue, New York, N. Y.

CIRCLE NO. 99 READER SERVICE CARD 99

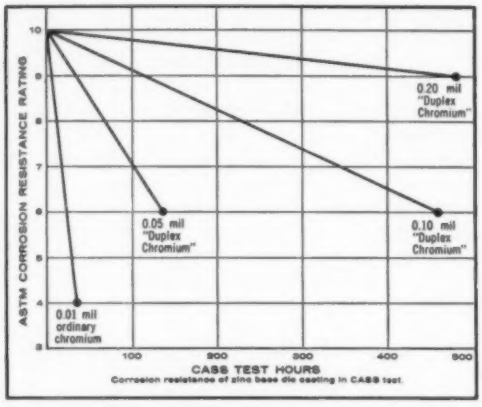
News about COATINGS FOR METALS

from Metal & Thermit Corporation

How to get the optimum protection of bright chromium plating

There are three requisites to increasing corrosion protection from chromium plating. (1) The deposit must be sufficiently thick. (2) There should be a crack-free chromium base topped by a special, finely cracked chromium deposit. (3) The plate should be more uniformly distributed over the part, so that recessed areas, too, are assured at least 0.03 mils minimum chromium thickness.

All of these requirements are easily met through UNICHROME SRHS® CHROMIUM plating processes. Work done for the automotive industry, long plagued by corrosion of brightwork in outdoors exposure, provides a good case in point.



Zinc die cast specimens, all plated with 0.75 mil copper and 0.75 mil nickel prior to chromium lasted as shown above in the severe CASS test (Copper accelerated acetic acid salt spray). Ordinary chromium fared poorly. Optimum protection was approached by using Crack-Free Chromium and increasing the deposit thickness.

•

AN ANSWER TO OUTDOOR CORROSION

Note the results in the chart at right. In all cases, the thickness of undercoats was kept constant. Only the chromium plate was varied... from ordinary to "Duplex", and progressively thicker. M&T "Duplex Chromium" calls for first using Unichrome Crack-Free Chromium and its ability to throw into recesses and give a more uniform and fracture-free plate. This is followed by another deposit of Unichrome SRHS Chromium, with its *controlled* cracking. With increasing thickness, the protection increased tremendously. Durability as determined by rigorous, accelerated corrosion testing techniques was multiplied as much as *20 times.*

Despite severe service conditions, automotive brightwork can stay bright now, due to the additional corrosion protection that M&T "Duplex Chromium" provides.

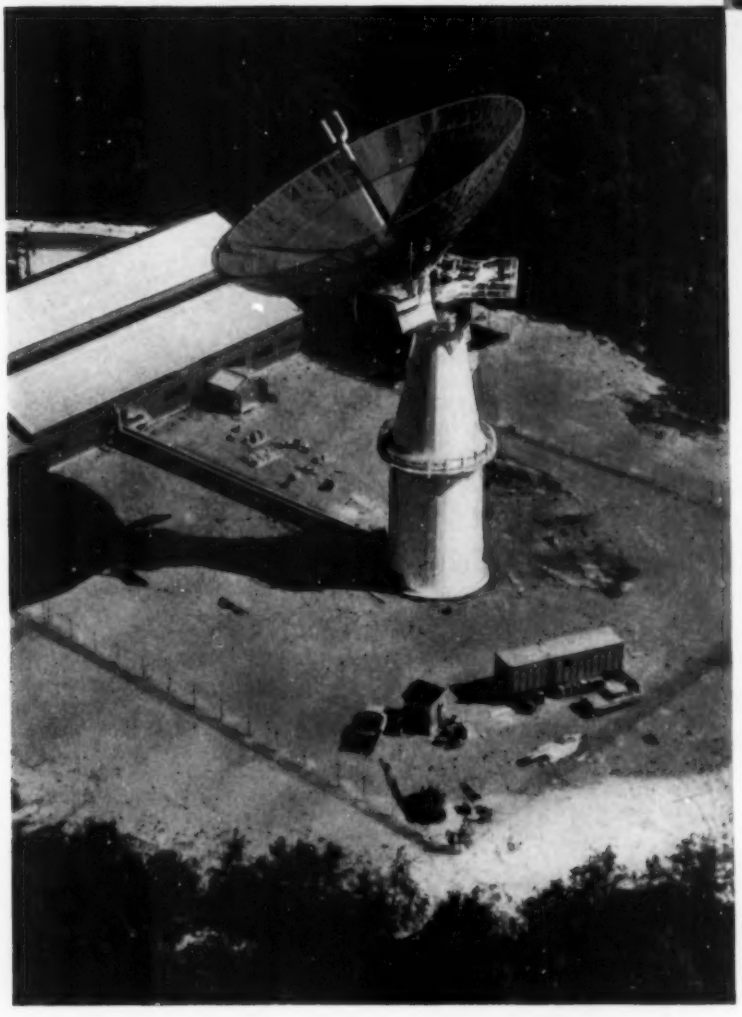
WIDELY USEFUL FINISH

While the above case concerns itself specifically with an automotive problem, it indicates what thicker chromium in general, and crack-free chromium in particular can do for other design problems involving corrosion and wear. This plate blocks infiltration of corrosives to underlying metal.

Technical Papers giving full details on the advantages of thicker chromium deposits are available for the asking. Write METAL & THERMIT CORPORATION, Rahway, New Jersey.

METAL & THERMIT CORPORATION

To Venus and back in 5 minutes with the help of Penmetal Squarex



Here is the 84-foot diameter space antenna used to establish contact with the planet Venus — some 28 million miles distant. Built by D. S. Kennedy & Co., it is installed at MIT's Lincoln Laboratory at Westford, Massachusetts. Microwaves beamed from the upturned reflector made the round trip in about five minutes.

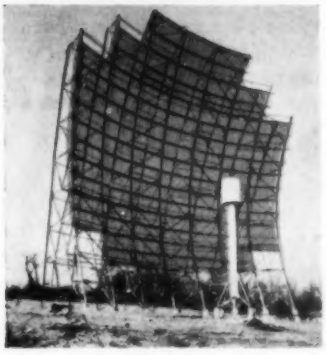
Within the periphery of the dish is *Penmetal Squarex*®, an expanded aluminum mesh having square openings instead of the usual oblong diamonds. The most versatile reflecting surface yet developed for radio, radar and telemetry reception, it provides constant response for radio energy regardless of polarization. In addition, this mesh is extremely strong, yet light in weight. The pattern was evolved through the joint efforts of D. S. Kennedy & Co. and Penn Metal Company.

Squarex is available in a range of mesh sizes from ¼" to 2⅜", to cover frequencies from less than 100 megacycles to more than 10,000 megacycles. It is made in either aluminum or steel.

Squarex is only one example of many unique products developed by Penn Metal Company in cooperation with industrial designers during the last 90 years. This experience is available to you for the development of special meshes to meet your individual requirements. Write for further details.

PENN METAL COMPANY, INC.

General Sales Office: 40 Central Street, Boston 9, Mass.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg, St. Louis



This 120-foot antenna was designed and built by D. S. Kennedy & Co., of Cohasset, Mass., for long-distance radio communication. Here, too, the reflecting surface is *Penmetal Squarex*.

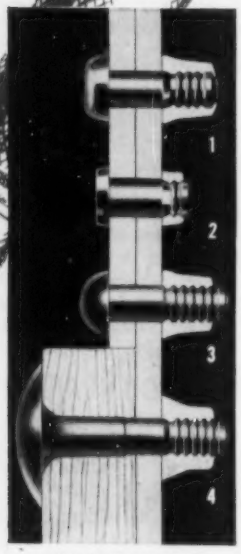
PENN METAL COMPANY INC. 90th YEAR 1869 – 1959

PM-219

*Trade mark registered; patent applied for.

CIRCLE NO. 101 READER SERVICE CARD 101

- LOW INSTALLED COST
- POSITIVE MECHANICAL LOCK
- EXCELLENT PULL-TOGETHER
- UNSKILLED, ONE-MAN APPLICATION
- UNIFORM CLINCH
- BROAD GRIP TOLERANCE
- EASY REMOVAL
- HIGH SHEAR & TENSILE STRENGTH
- NO LOOSENING OR STRIPPING
- BROAD BEARING
- NO LOOSENING BY OVERDRIVING



1 TENSION TYPE FASTENER
2 FEATHERWEIGHT TYPE FASTENER
3 BROAD GRIP TOLERANCE FASTENER
4 BROAD BEARING FASTENER

Huckbolt fasteners have effected savings of as much as 70% over previously used fastening methods.
These versatile, efficient fasteners are available in diameters, grips, headstyles and metals to suit your needs.
Lightweight, sturdy, easy-operating Huck power or hand tools install these fasteners with absolute uniformity at rates up to sixty per minute by one unskilled operator.
Let Huck's experienced fastener engineers help you with your fastening problem.

*T.M. of Huck Manufacturing Company

HUCK MANUFACTURING COMPANY

2480 BELLEVUE AVENUE • DETROIT 7, MICHIGAN • Phone WAlnut 3-4500

102 CIRCLE NO. 102 READER SERVICE CARD

perature properties, chemical composition, size ranges and short-time tensile and rupture properties of Croloy 25-12 (309). Tubular Products Div, Babcock & Wilcox Co, Beaver Falls, Penna.

Circle 341, Reader Service Card

COST OF METAL PARTS FINISHING—Cost guide folder, 6 pp. Designed to determine and compare costs in metals finishing procedures on premises, off premises and using prefinished metals. Presents not only raw material prices, but also costs and expenses frequently overlooked. Apollo Metal Works, Dept PE-1, 66th Pl and S Oak Park Ave, Chicago 38.

Circle 342, Reader Service Card

MINIATURE SELF-LOCKING FASTENERS—Catalog 5711, 32 pp. Presents latest designs and configurations in miniature self-locking fasteners for assembly of electronic and avionic equipment. Charts compare size of standard AN parts and NAS miniature nut standards. Includes 18 pp of standard drawings. Dept M, Elastic Stop Nut Corp of America, 2330 Vauxhall Rd, Union, NJ.

Circle 343, Reader Service Card

MACHINED BRASS NUTS—Brochure, 12 pp. Engineering specifications on machine screw nuts, AS hexagon nuts, cap and open-cap nuts, knurled thumb nuts, battery and spark-plug nuts, fixture eyelets, lamp and lighting fixture parts, volume control, potentiometer and switch nuts. Cornell Mfg Co Inc, 21B Saw Mill River Rd, Yonkers, NY.

Circle 344, Reader Service Card

BLIND RIVETS—Folder 8-457, 4 pp; brochure 8-409, 8 pp. Folder outlines features, applications and installation of aluminum self-plugging blind rivets. Brochure describes and illustrates PT and 9SP blind rivets. Both include information on material specs, shear and tension strength values, hole size recommendations and shop practice notes. Grip ranges for all sizes are tabulated. Huck Mfg Co, 2480 Bellevue Ave, Detroit 7.

Circle 345, Reader Service Card

WIRE FORMS—Guide, 4 pp. Contains design suggestions on how to achieve lower wire products part costs, information on how to specify and order and information on manufacturers facilities. Covers wire forming, strip forming, cold heading and threading. Robertson Steel & Iron Co, 201 Commerce St, Cincinnati 2.

Circle 346, Reader Service Card

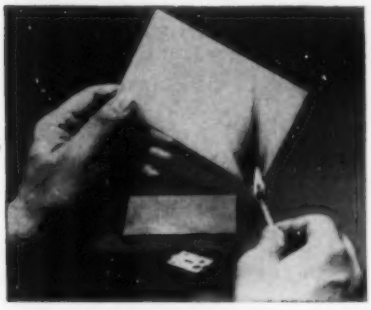
STRIP HEATERS—Bulletin SHA, 4 pp. Describes and diagrams forms of thin-strip electric heating elements for heat

(Continued on page 107)

PROGRESS IN PLASTICS

NEW FLAME-RETARDANT EPOXY LAMINATES OFFER HIGH STRENGTH-WEIGHT RATIO, LOW LOSS

Much is being said lately about the fabulous epoxies. No better use, however, has been made of these remarkable resins than the development by CDF of new improved laminates for electrical-insulating purposes.



New CDF epoxy Dilecto laminate exhibits flame-retardancy in simple match test.

CDF epoxy Dilecto® laminates, made with either treated glass-cloth or cellulose-paper base, combine the highest strength-to-weight ratio and the highest impact strength with low water-absorption, low loss properties, and improved machinability. The new epoxy Di-Clad® laminates for printed-circuit use also display exceptional foil-bonding strength, high hot-solder-resistance, and higher maximum operating temperatures than previously obtainable in standard laminates.

And now permanent flame-retardancy and excellent arc-resistance are added to many grades of epoxy laminates from CDF, both GB and XXXP. These laminates, known as the EFR series, meet NEMA G-11 and MIL-P-18177B, Type GEB. This combination of properties should further widen the range of applications for this superior insulating material. CDF Technical Bulletin 11200 describes epoxy Dilecto and Di-Clad laminates in detail.

REUSABLE INSTRUMENT-SHIPPING CASES

Replacing heavy, costly wooden cases for the transport of delicate aircraft and electronic instruments, CDF now offers fiberglass-reinforced polyester cases containing integral rubber-coated kapok cushioning, built for repeated usage with a wide range of instrument sizes and shapes. The complete line of new CDF instrument-shipping cases ranges in size from 12″ x 14″ x 7″ to 25½″ x 11″ x 12½″.

Measuring instruments packed for shipping in CDF laminated-plastics cases.

Savings through use of these cases are realized in original cost (10% lower than for wooden cases) and in their long useful life without wear or breakage. Request Bulletin MHC-591.

SKIVED TAPES OF UNSUPPORTED TEFLON

Four new grades of tape, made of skived duPont "Teflon" TFE fluorocarbon resin, are now available from CDF. Excellent electrical properties, resistance of all common chemicals, and a low coefficient of friction characterize these new tapes, designed primarily for high-temperature and high-frequency wire and cable insulation. However, they may be used also as stock from which gaskets, seals, and miscellaneous small parts can be cut.

CDF tapes of Teflon range in width from ¼″ to 12″ in ⅛″ increments, in thickness from .002″ to .100″. Request Technical Bulletin 97.

NEW CDF LITERATURE • *Bulletins referred to in this advertisement may be obtained from your CDF representative; or send the coupon below, indicating the Bulletins you wish sent to you.*

Continental-Diamond Fibre Corporation
Newark 40, Delaware

Please send me the following Technical Bulletin(s):

- ☐ Bulletin 11200—CDF epoxy Dilecto and Di-Clad laminates
- ☐ Bulletin MHC-591—CDF reusable instrument shipping cases
- ☐ Bulletin 97—CDF skived Teflon tapes

Name_____ **Title**_____

Company_____

Street Address_____

City_____ **Zone**_____ **State**_____

CONTINENTAL-DIAMOND FIBRE

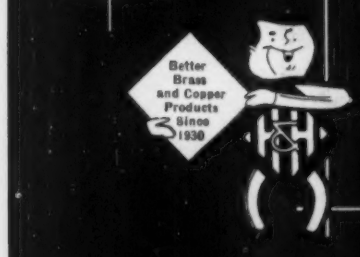
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 40, DEL.

In Canada: 46 Hollinger Road, Toronto 16, Ontario

PLANNED FOR PRECISION

Jim: This year why not talk to H+H about our tubing problems. J.B.*

*Although it may be some time before you actually begin production, you're sure to get your next air conditioning season off to a good start by talking to the man from H & H *now*. Every year about this time our design engineers and metallurgists help more and more manufacturers develop better, more economical parts designs. Why not give us an opportunity to do the same for *you*.



H&H TUBE & MFG. CO.

247 North Forman Ave. Detroit 17

OFFICES COAST TO COAST

Both now available off-the-shelf!

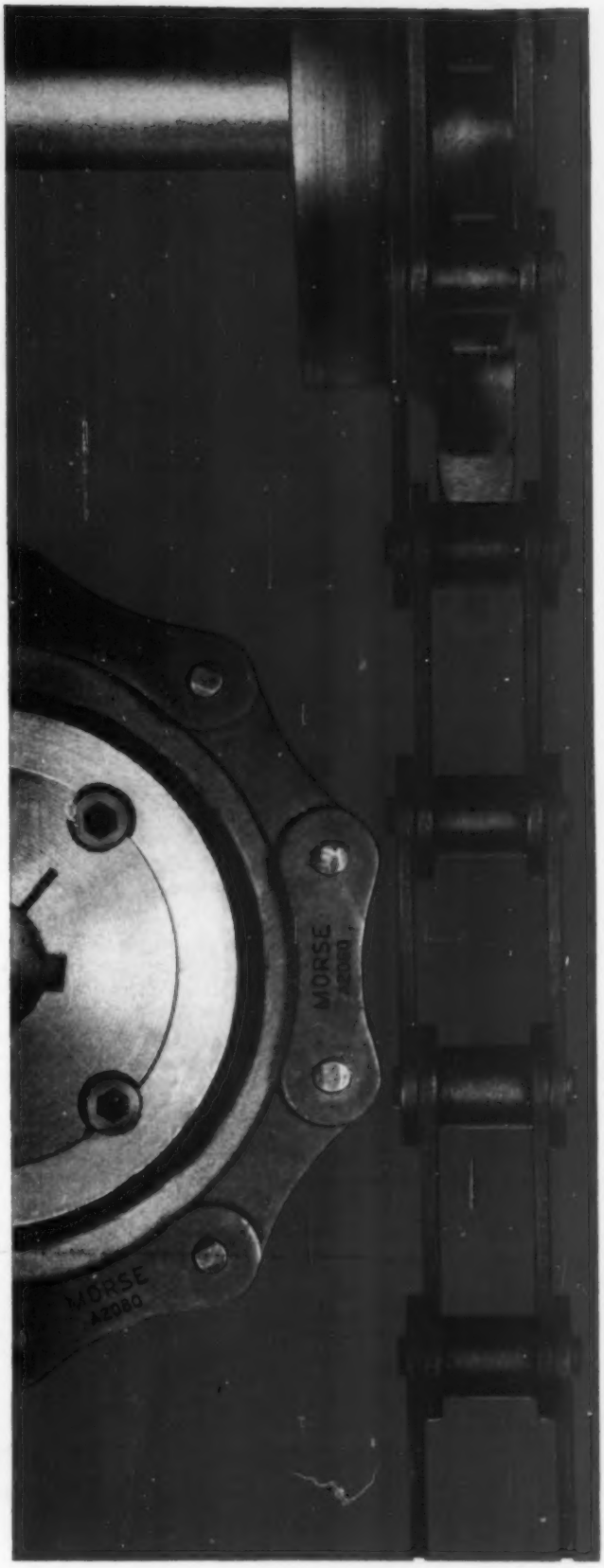
Morse double-pitch chain and sprockets... the perfect pair for double wear!

When it comes to single-strand chain for low-speed applications, you just can't beat Morse double-pitch chain coupled with Morse double-pitch, double-duty stock sprockets. These Morse components provide a lighter, smoother, more compact transmission—with much longer life than regular pintle, conveyor, or fabricated chain. And both are available for immediate off-the-shelf delivery.

You see, Morse double-pitch chain is precision-made to A.S.A. standards, lightweight, and smooth running—just like Morse roller chain! Packed conveniently in 10-ft. lengths, Morse double-pitch chain is available in 1″ to 2″ pitch in power transmission and 1″ to 2½″ pitch in conveyor series.

And Morse Taper-lock® double-pitch stock sprockets—with "alternate-tooth" design of 17, 19, 21, 23, 25, or 35 teeth—give you double the wear over ordinary sprockets; available off-the-shelf, *require no additional machining!* Unique easy-on, easy-off Taper-lock assembly minimizes costly downtime, too!

So, whether you're concerned with packaging or farm machinery, conveyor or timing drives (or with most any transmission problem—up to 500 rpm), Morse double-pitch transmission chain and double-pitch stock sprockets are the answer! Check with your Morse distributor today. He's listed in the Yellow Pages under "Power Transmission." Morse Chain Company, Industrial Sales Dept. 4-79, Ithaca, New York. Export Sales: Borg-Warner International, Chicago 3, Illinois. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ontario.



MORSE* A BORG-WARNER INDUSTRY

*Trademark

ONLY MORSE OFFERS ALL FOUR: Roller Chain, Silent Chain, Hy-Vo® Drives and "Timing"® Belts.

CIRCLE NO. 105 READER SERVICE CARD

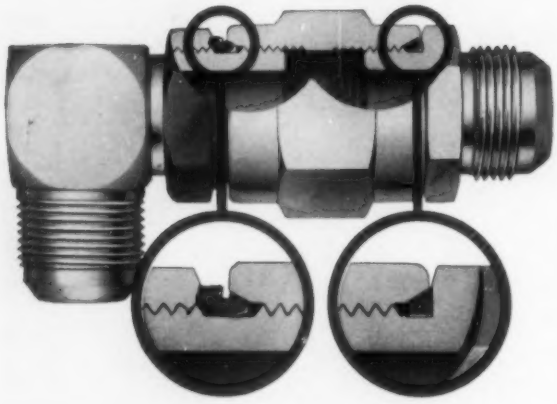
See Your L&L Man if you are...

HAVING PORT SEALING PROBLEMS

L and L

CAN HELP YOU WITH

"CN" METAL SEAL



SOLVE FLUID LEAKAGE

Wedging action of metal sleeve against taper in the port makes pressure-proof joint.

Positive metal seal is unaffected by fluids, temperature, high pressures or vibration.

"Connect up with L and L"
Write for Catalog CN-59

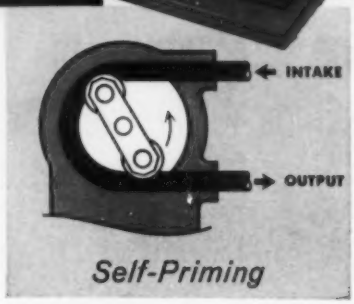
Representatives in Principal Cities

L and L MANUFACTURING CO.
P.O. Box 292
East Detroit, Michigan

THE VERSATILE *NEW*
RANDOLPH PUMP

Safely and efficiently handles...

- CORROSIVES
- ABRASIVES
- STERILE SOLUTIONS
- GASES



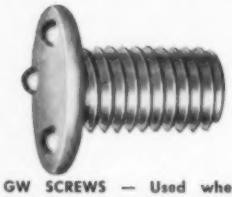
Operates on a principle designed to eliminate all contact of moving parts with the material being pumped. A tube is threaded through the pump body where it is subjected to the squeegee action of a double rotor. The result is a smooth flow of liquid or gas through the tube. Ideal for jobs where corrosion, contamination or abrasion is a problem. Two models — 54 and 185 gallons per hour. Available with or without motor; also with speed controls and explosion-proof fittings.

For dealers in your area contact

THE Randolph COMPANY / 1018 Rosine St, Houston 19, Texas JAckson 6-2091

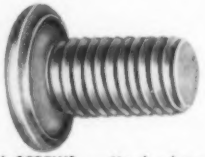
CIRCLE NO. 204 READER SERVICE CARD

OHIO WELD SCREWS

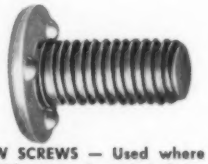


GW SCREWS — Used where design requires a smooth unmarred surface and a fastener permanently fixed in place.

HH SCREWS — Used where a single, button-type projection is required when welding to curved surfaces, to heavy sheet 3/32" or thicker, or to ends of rods.



RW SCREWS — Used where a hermetic seal is required to prevent leakage of air, gas, water, oil or dust, or when welding to perforated metal or wires.



HW SCREWS — Used where a self-locating through bolt is required to be fixed securely in place so that it will not turn and a flush surface is required for attaching mating parts.

Thread Size 6-32 to ⅜-16

Samples and information available upon request.

The OHIO WELD FASTENERS Primary Fastener in Fastener Assemblies

THE OHIO NUT AND BOLT CO.
41 FIRST STREET BEREA, OHIO

CIRCLE NO. 106 READER SERVICE CARD

CIRCLE NO. 205 READER SERVICE CARD

transmission in 100 to 1200-F range. Shows typical applications, suggested wattages, sizes, and prices. Acra Electric Corp, Franklin Park, Ill.

Circle 347, Reader Service Card

COUNTERS—Condensed catalog, 4 pp. Describes and illustrates, for first time, high-speed electronic counters and also shows some of standard mechanical and magnetic counters. Veeder-Root Inc, Hartford 2, Conn.

Circle 348, Reader Service Card

PORTABLE SWITCHES—Folder, 2 pp. Describes attachable-pendant toggle switches, molded-to-cable precision switches, standard pushbutton switches, side-mounted toggle switches and end-location toggle switches. Features pendant pushbutton station on short-fold. Joy Mfg Co, Dept S-48, 1201 Macklind Ave, St Louis.

Circle 349, Reader Service Card

TURBINE FLOWMETERS—Bulletin 1384, 4 pp. Discusses new design, presents specifications and describes Type 20 turbine flowmeters for measuring flow of jet fuel, gasoline, oil, water, acid and alkali chemicals and other liquids. Cox Instruments Div, Geo L Nankervis Co, 15300 Fullerton Ave, Detroit 27.

Circle 350, Reader Service Card

EXPLOSIVE ORDNANCE—Technical data folder. Contains product specifications, performance data, descriptions and illustrations on explosive ordnance products made by company. McCormick Selph Assoc., 2722 Ardmore Ave, Manhattan Beach, Calif.

Circle 351, Reader Service Card

MOLDED CUPS—Bulletin AD-145, 8 pp. Details construction, recommended service and available sizes of molded cups for pump pistons, hydraulic service and pneumatic equipment. Also contains tables of most popular cups for recommended services for a variety of applications. Section is devoted to conversion of pistons designed for operation with hydraulic ring packings to pistons for use with pump cups. Garlock Packing Co, 436 Main St, Palmyra, NY.

Circle 352, Reader Service Card

STANDARD ELECTRIC MOTORS—Bulletin 103 D9, 4 pp. Lists 138 standard electric motors, with specifications for line of 1/30 to 1-hp motors and price lists. Motor Appliance Corp, 5737 W Park Ave, St Louis 10.

Circle 353, Reader Service Card

LIGHTWEIGHT PIPING—Bulletin TT 942, 6 pp. Dimensions are given for line

(Continued on page 110)

No. 5 of a Series

GRIPPING STORIES
from the files of Angier Adhesives

The Case of the COSTLY CONTACT

Acme had a problem. Their new line of sandwich panels was so popular they couldn't make them fast enough. So they turned to automation. The honeycomb cores were conveyed past automatic adhesive spray guns—through drying lamps and on to "Assembly" where the faces were contact-bonded to the body of the panel.

Then Acme discovered another problem. Their adhesive was being deposited unevenly and they were getting surprisingly poor mileage from their new installation.

Acme called in an Angier man. He showed them how a specially-formulated Angier contact cement would spray smoothly and uniformly, even at maximum line speeds, and with no heavy edges or excessive overspray.

In addition to a full line of contact cements and other adhesives, Angier offers unequalled application know-how. This vast fund of practical knowledge has been gained by the service engineers of Interchemical's Finishes Division in their daily experience with some of the largest industrial lacquer and enamel users. For *real* economy in adhesives, call in an Angier man *first*.

Call or write today for more information on Angier's line of Contact Cements.

ANGIER ADHESIVES

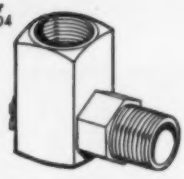
INTERCHEMICAL CORPORATION
Finishes Division
120 Potter St., Cambridge 42, Mass.
Midwestern Plant: HUNTINGTON, IND.

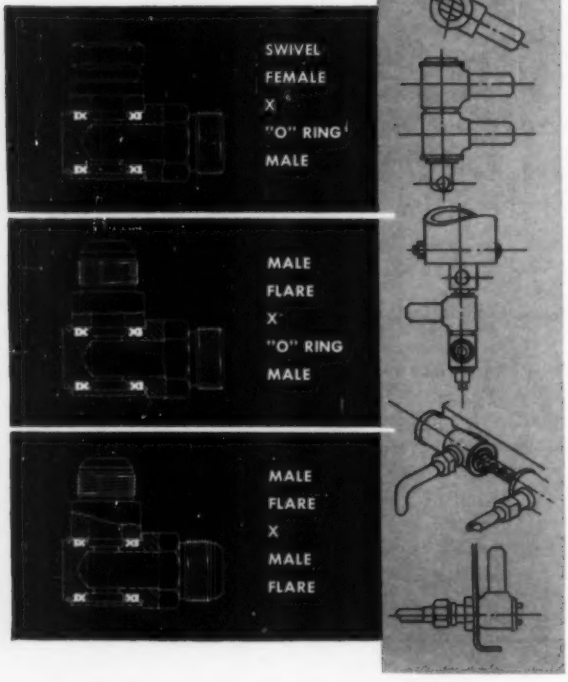
CIRCLE NO. 107 READER SERVICE CARD 107

Eastman offers INDUSTRIAL SWIVEL CONNECTOR

to eliminate hydraulic hose failure under severe flexing

Licensed Under Pat. No. 2481404





If you have been designing "around" metal swivel joints because of high cost, EASTMAN now offers an economical swivel connector for industrial use—precision engineered to assure adequate freedom of motion—proved under the most rigid government requirements.

Unique design assures "balanced" flow of hydraulic fluid at required pressure—at any angle. Fluid pressure is also balanced by a *double seal* assembly at each end of stem. Pressure-Balance assures equal internal pressure, causing the body to float about the stem, free of end load and friction.

Eastman Swivel connectors will make your flexing installations the most reliable link in your Hydraulic Assembly.

APPLICATIONS:
For use on Cranes, Loaders, Earth Moving Equipment, Hydraulic Presses, Shears, etc.—wherever unusual flexing and exposure may shorten hose life or cause premature failure and frequent replacement.

ECONOMY:
Permits use of shorter hose lengths since less hose allowance is needed for complete extension. Shorter lengths of longer lasting, multiple spiral wire high pressure hose may be used, since Swivel Connector absorbs flexing motion.

ADAPTABILITY:
Body of Connector available with any combination of ends. Now available in types and sizes shown at left. Various combinations of stems can be interchanged with any body style.

WRITE, WIRE or CALL about Eastman Swivel Connector Opportunities in Your Line.

STANDARD SIZES AND COMBINATIONS AVAILABLE

●

LOW TORQUE—Freedom from friction, even under high pressure.

WIDE RANGE—Operating pressures up to 5000 PSI. Trouble-free operation through wide temperature range.

ROTATION—Full 360° for all manifolds.

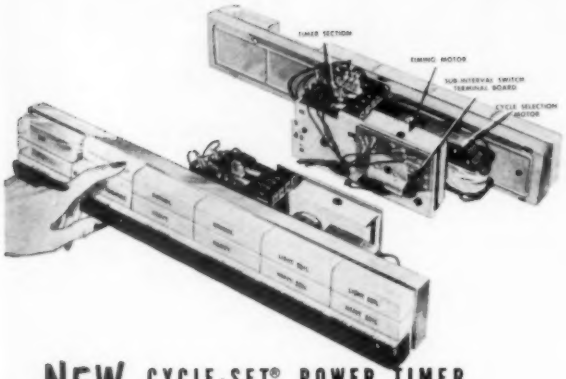
SIZES—Steel, plated for corrosion protection—½" thru 1½".

Eastman
first in the field MANUFACTURING COMPANY
Dept. PE-7, MANITOWOC, WISCONSIN

SAFEGUARDING AMERICA'S LIFELINES OF MOBILE POWER

Attention! You are now entering a new era of total controls purchasing ...the era of

CC SYSTEMS



NEW CYCLE-SET® POWER TIMER

. . . a completely integrated control system for washers, dryers, combinations. Pushing a single button establishes wash-cycle time, wash-rinse temperature, spin-agitation speed. Entire operation is automatically placed in the cycle best suited to the fabric being washed and the degree of soiling. It's the only control available that automatically sets up the right operating cycle for all washing or drying conditions.

NOT only components — but complete, product-integrated control systems — that's the new total approach of Controls Company of America. Purpose: to give manufacturers the extraordinary benefits of CC's stand-out research and development staff . . . to replace dangerous "scatter-buying" with one-source dependability of highest quality.

Shown here are the first two steps in the vanguard of CC's Control Systems Approach. Write for all the facts . . . see what this approach can mean to you.

NEW AUTOMATIC DIRECT-SPARK GAS IGNITION SYSTEM

. . . eliminates the No. 1 gas-dryer service problem: the trouble-making combination of glow coil and pilot. This new, totally automatic, self-contained system provides ignition by means of an intense electric spark applied directly to the main burner of the gas dryer. Easy to install, the system has been extensively tested. It is proved and ready to deliver safe, sure-fire gas dryer ignition . . . every time.

Creative Controls for Industry

CONTROLS COMPANY OF AMERICA

9563 Soreng Avenue • SCHILLER PARK, ILL.
COOKSVILLE, Ontario • Postfach 313, ZUG, Switzerland

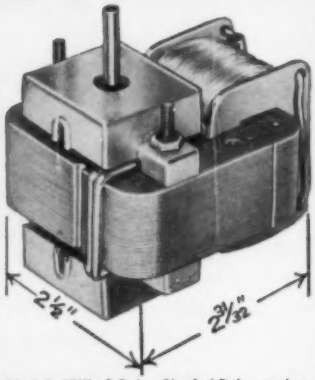
GENERAL INDUSTRIES

Smooth Power

AC MOTORS

1/1000 H.P. to 1/35 H.P.

Greatly Increased Oil Capacity... for long range peak efficiency



Model "H" 2-Pole Shaded-Pole motor 1/550 H.P. to 1/50 H.P. designed and constructed with features that assure thousands of **extra hours** of service under the most adverse operating conditions. Rugged, quiet, smooth running. Available in nine models that cover a wide range of applications.

OIL CAPACITY MANY TIMES GREATER THAN CONVENTIONAL MOTORS

Oversized oil bearing reservoirs hold considerably more oil and wicking. A revolutionary new method of packing the wicking assures equal distribution of oil at all times resulting in quieter operation and longer trouble-free life.

DIE-CAST BEARING BRACKET

The new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

Motors For All Types of Applications

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

Catalogs and Bulletins . . . . . continued

of lightweight welding fittings, and advantages listed for use of lightweight carbon steel piping. Tube Turns, Div of Chemetron Corp, Louisville 1, Ky.

Circle 354, Reader Service Card

GEAR PUMPS—Bulletin G-1, 4 pp. Describes types and models of gear pumps for pressures up to 1000 psi and to handle low viscosities or up to 10,000,000 ssu. Includes dimensional information and driving-power requirements. Schutte & Koerting Co, Dept P-G, Cornwells Heights, Bucks County, Penna.

Circle 355, Reader Service Card

ADJUSTABLE-SPEED DRIVES—Bulletin, 2 pp. Condensed-specifications bulletin describes line of adjustable-speed drives for 1/6 to 10-hp applications. Cleve-Machine Controls Inc, 1155 Brookpark Rd, Cleveland 9.

Circle 356, Reader Service Cadr

BIMETAL THERMOSTATS—Bulletin 8400, 4 pp. Covers 19 major types of bimetal thermostats. Illustrates main thermostats, gives condensed specifications, operating ranges and ratings. Incorporates Centigrade-Fahrenheit temperature conversion chart. Stevens Mfg Co Inc, PO Box 1007, Mansfield, Ohio.

Circle 357, Reader Service Card

IN-LINE FILTER ASSEMBLIES AND FILTER ELEMENTS—Catalog BFD-64, 6 pp; catalog BFD-48, 4 pp. Describes five standardized lines of T-type in-line filter assemblies, replacement filter elements, dual bowl filters and differential pressure indicator filter assemblies. 4-pp brochure discusses nine basic filter element materials. Illustrated with cross-section and microscopic photos. Bendix Filter Div, Bendix Aviation Corp, 434 W 12 Mile Rd, Madison Heights, Mich.

Circle 358, Reader Service Card

TUBING AND FACILITIES—Catalog CF-3, 12 pp. Describes carbon and alloy seamless steel tubing in mechanical, pressure, aircraft mechanical and airframe grades. 3-pp fold-out flow chart illustrates production steps. Also covers electric-welded carbon steel tubing, forging and fabricating operations, special tubular shapes and a gage-decimal chart. Ohio Seamless Tube Div, Copperweld Steel Co, Shelby, Ohio.

Circle 359, Reader Service Card

MINIATURE INDICATOR LIGHTS—Brochure L-160A, 8 pp. Discusses lights with built-in lamps and lights with replaceable lamp cartridges. Presents features, specifications and schematics of lights, lamp holders mounted on strip

(Continued on page 114)

VELLUMOID

NOW

VELLUMOID

IT'S VELBUNA WG-1!

Latest in Vellumoid's line of outstanding gasketing materials.

VELBUNA WG-1
Excellent for applications involving medium or high compression loads requiring both firmness and conformability.

VELBUNA WG-1
Compounded of high grade fibre and Buna N synthetic rubber combined by a special process.

VELBUNA WG-1
A dense, homogeneous sheet with outstanding sealing characteristics

VELBUNA WG-1
Excellent torque retention

VELBUNA WG-1
Your answer to a wide range of services involving oils, greases, fuels, and water

We'll be happy to furnish samples for testing on your particular application.

Write Today . .
THE VELLUMOID COMPANY
54 Rockdale St.,
Worcester, Mass

VELLUMOID

WRITE TODAY!
THE VELLUMOID COMPANY
WORCESTER, MASS.

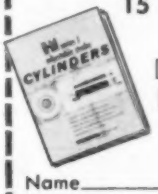
JUST a turn of the end on the adjusting rod and the stroke of this versatile O-M Cylinder is lengthened or shortened to fit the operation. This is accomplished with micrometer accuracy in a moment from the outside of the cylinder without disassembling or unmounting the unit or extra parts. Thus, you get the advantage of a special cylinder with no additional cost.

OTHER ADVANTAGES. Fits where others won't. All-steel construction with bearing surfaces of bronze. Designed right to seal right. Rod has high yield point. Can be disassembled and assembled faster than tie-rod types. Delivers continuous, smooth, dependable power at low or high speeds. Port can be oriented to any position. End plugs are tapped for universal mounting.

Available in a complete range of sizes (1½" to 8" bore) with standard, 2 to 1 or oversize rods. Also full line of mounting brackets interchangeable bore for bore. Immediate delivery on many sizes.

Mail coupon *TODAY* for Bulletin 112 featuring O-M Adjustable Stroke Air and Hydraulic Cylinders.

ORTMAN-MILLER MACHINE COMPANY
15 143rd Street, Hammond, Indiana



☐ Have representative call
☐ Send Bulletin 112

Name_____ Position_____
Company_____
Address_____
City_____ Zone_____ State_____

BARBER COLMAN

Founded in 1900 for the purpose of building textile machinery, Barber-Colman Company today produces diversified equipment and products for such fields as automotive, aviation, machine tool construction and textile.

Versatile ACIPCO

centrifugally spun TUBES

...for super speed warpers

Barber-Colman Company, Rockford, Illinois, manufactures more than 85% of the section beam warpers produced in the world. And Barber-Colman specifies ACIPCO Centrifugally Spun Cast Iron Tubes as supplied through our mid-west distributor, C. A. ROBERTS CO.

The Super Speed Warpers produced by Barber-Colman have a winding speed of 900 yards per minute yet these units are also engineered for low and uniform tension to produce a beam in which thread ends are stressed alike.

Specifications for the machines are strict: tubular metal parts must be machined to a fine finish and to precise measurements. They must have high strength and be balanced so that they are capable of withstanding sustained high speeds. ACIPCO tubes **custom-fit** requirements such as these.

Centrifugally Spun ACIPCO tubes have a dense, non-directional grain structure which is easier to machine. Important, too, their **inherent** dimensional stability and concentricity makes dynamic balance easier to attain in finished products.

If your machines or products employ tubes of stainless steel, carbon steels, alloy irons, or special analyses as components, it will pay you to investigate ACIPCO. Call or write for complete information on ACIPCO tube applications in your field. No obligation, of course.

SIZE RANGE: Lengths up to 410″ have been produced to meet modern machinery requirements. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA

ACIPCO

Leading manufacturers of automatic washers and dryers rely on PLEXIGLAS® acrylic plastic for control panels of the highest quality in appearance and service. The crystal clarity of PLEXIGLAS moldings gives depth and sparkle to back-surface decoration. Panels are easily cleaned, resist breakage and discoloration. And one-piece molded PLEXIGLAS parts reduce assembly and parts inventory costs. We will be glad to help you add the magic touch of PLEXIGLAS to your appliance designs.

Chemicals for Industry

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Co. of Canada, Ltd., West Hill, Ontario*

CIRCLE NO. 113 READER SERVICE CARD 113

PALMETTO®
G-T RINGS

For ROD SEALS . . .

For PISTON SEALS . . .

PALMETTO G-T RINGS are resilient packing seals molded from a variety of natural or synthetic rubber compounds into T cross-sections, with two split non-extrusion backup rings on each side. They are used in hydraulic or pneumatic operations as rod or piston seals, in single or double acting systems; for all applications where there is reciprocating motion, with either constant or impulsed pressure; and as static seals, under constant or impulsed pressure.

PALMETTO G-T RINGS effectively seal, without extrusion, at temperatures from minus 70F up to 600F, and at pressures as high as 10,000 p.s.i. They will not wedge into clearances, pinch-off under motion or pressure, or twist in place. Absolutely resistant to destructive deformation, they permit the use (within reasonable limits) of greater clearances between the surfaces being sealed.

PALMETTO G-T RINGS are manufactured to fit standard size bores and rods, and are available in a wide selection of compounds compatible with all types of fluids in a broad temperature range. Special G-T Ring sizes can be made, on order, to meet any design requirement. Several kinds of non-extrusion backup ring materials are also available.

G-T Ring compound 160A complies with Military Specification:
MIL-R-003065 Grade SB 715 BE_3Z.

FREE ILLUSTRATED BOOKLET: Just published, this useful literature is complete with product descriptions, technical data, specifications, and suggested uses of PALMETTO G-T RINGS for the design engineer . . . Write for your copy of Booklet GTR-759 today.

Greene, Tweed & Co. manufactures a complete line of Palmetto Packings . . . to meet every sealing requirement . . . encompassing every design need:

PALMETTO PYRAMID	PALMETTO O-RING
PALMETTO U-RING	SELF-LUBRICATING PACKINGS
PALMETTO KUP	SHEET-PACKINGS
PALMETTO FLANGE	NON-LUBRICATED PACKINGS

Whatever your sealing problem, Palmetto engineers will give you personalized design service and work with you to engineer the specific type of packing your process or product requires.

packing more performance into every application

GREENE, TWEED & CO.
North Wales, PA.

Catalogs and Bulletins . . . . . continued

and lamp holders mounted on rectangular matrix. Dialight Corp, 60 Stewart Ave, Brooklyn 37, NY.

Circle 360, Reader Service Card

ELECTRONIC COUNTING AND CONTROL EQUIPMENT—Catalog 5920, 4 pp. General descriptions, specifications and illustrations of units for one or a score of industrial and manufacturing applications. Includes counters, preset interval generators and modular counters. Freed Transformer Co, Inc, 1745 Weirfield St, Brooklyn 27, NY.

Circle 361, Reader Service Card

LOW-DRIVING-LOAD BLIND RIVETS—Brochure, 6 pp. Engineering specifications, design solutions and driving sequence information on series of low-driving-load drive-pin blind rivets. Deutsch Fastener Corp, PO Box 61072, Los Angeles 61.

Circle 362, Reader Service Card

TOOL TEMPLETS—Booklet, 8 pp. Contains full-scale tracing templets of over 200 components used in machine tools. Can be used as tracing templets to reduce layout time and eliminate details. Also encourage use of standard items. Northwestern Tools Inc, 126 Hollier Ave, Dayton 3, Ohio.

Circle 363, Reader Service Card

COST OF EQUIPMENT LEASING FOR SMALLER BUSINESS—Report, 19 pp. Compares leasing with outright purchase and purchase through conditional sales contract. Single copies are free. Foundation for Management Research, 121 W Adams St, Chicago 3.

Circle 364, Reader Service Card

Letterhead Requests Only

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

FORCE-BALANCE PRESSURE TRANSDUCERS—Brochure 1000 SD 6, 32 pp. Describes three basic force-balance pressure transducers, static pressure, pressure ratio, and pressure difference. Typical construction is shown in open-frame photos. Includes dimensional drawings, schematics and performance curves. M Ten Bosch Inc, Pleasantville, NY.

TFE-FLUOROCARBON RESINS—Handbook, 24 pp. Covers electrical and electronic properties of fluorocarbon plastics, suggests design considerations for systems and reviews specific applications in which resins solved a particular design problem. Includes tables and graphs. E I Du Pont de Nemours & Co Inc, Wilmington 98, Del

HOTWATT®
CARTRIDGE HEATING UNITS
ARE THE
FASTEST ANSWER!

For fast heat-up, high-density heat, HOTWATT Precision Cartridge Heating Units are tailor-made to solve your problem. HOTWATT's unique production system offers a wide range of standard heating units . . . in diameters from ⅛" up . . . with lengths, wattage and voltage to meet your requirements.

Standard cartridge heaters have precision-dimension stainless steel sheaths (special alloys available) . . . operate at up to 1250°F., any specified voltage . . . nickel alloy leads swaged to rigid external terminals . . . straight or right-angle leads . . . moisture-resistant units. Special heating cartridges in special shapes with sheath materials as designated. Power dissipation as low as 5 watts. Terminal or lead arrangements to specification.

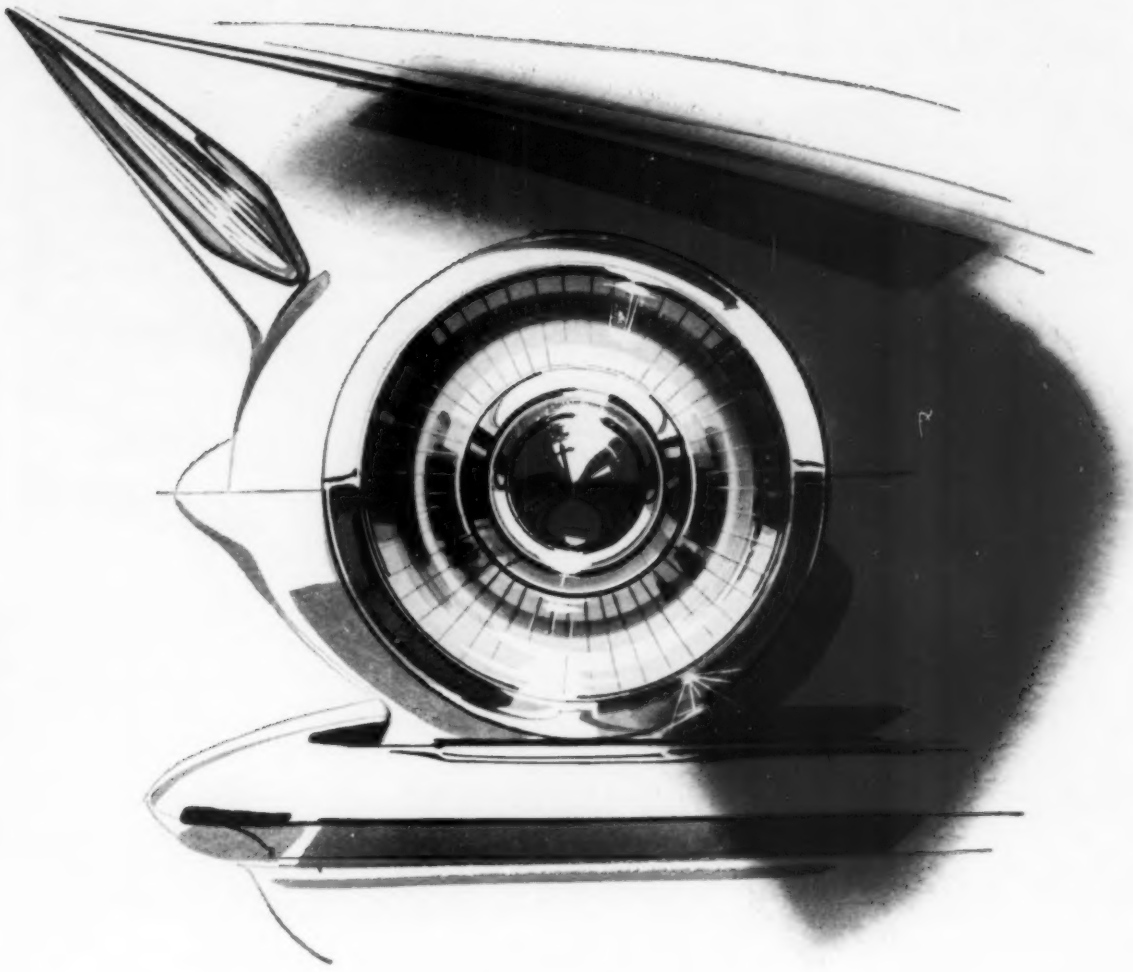
Low-cost ceramic-body units are also available to your design and specifications; sizes as small as 5/32" . . . lead arrangements and terminals to meet your requirements.

For fast delivery you can depend on HOTWATT. Whether you want standard or customized units . . . in short or long runs . . . HOTWATT will meet your "specs" and delivery schedule.

NEW CARTRIDGE HEATER GUIDE helps you get heat in a hurry

Bulletin 200
request your
FREE copy today

HOTWATT, INC.
75 Maple Street • Danvers, Mass.
Electric Heating Specialists



FIRESTONE FASHIONS "TRAFFIC STOPPERS" IN fashionized ALUMINUM PARTS

Call on the eye-catching brilliance of Firestone brightwork to put new competitive appeal into your automotive products.

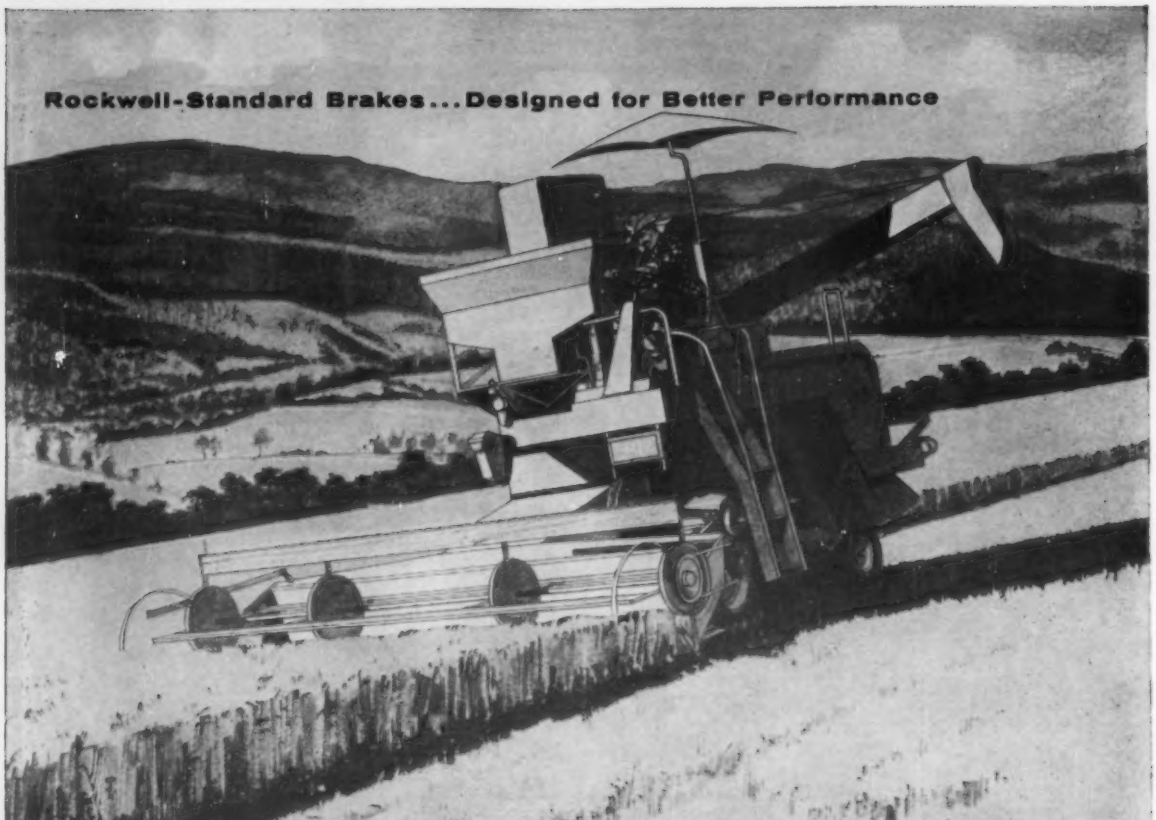
Call on Firestone Fashionized® Aluminum for the finishing touches your new cars need. Call on the custom colors and qualities of this mass-produced medium to pass your closest customer inspection—to say "craftsmanship" down to the last detail.

Call on Fashionized Aluminum, and on Firestone's more than 50 years of fabrication and finishing experience. Call, too, on the production capacities and competitive prices that only an automated anodizing line can supply—in part sizes up to seven feet long. Your inquiries and inspections are cordially invited.

FIRESTONE FASHIONIZED ALUMINUM
FIRESTONE STEEL PRODUCTS COMPANY, AKRON 1, OHIO

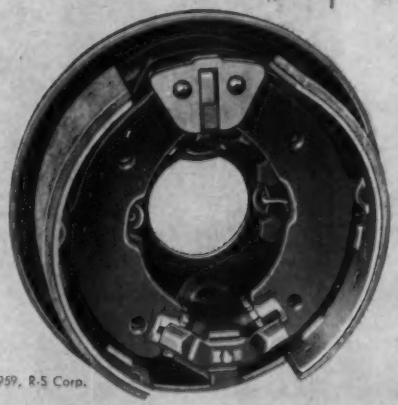
CIRCLE NO. 115 READER SERVICE CARD 115

Rockwell-Standard Brakes...Designed for Better Performance



"DM" DUPLEX MECHANICAL BRAKES

...dependable "reins" for a stable of workhorses



Tames a variety of horsepower. The "DM" Duplex Mechanical Brake has proved its worth with farm equipment, special duty utility trailers, light duty highway trailers, industrial machinery, and in many special applications.

Gives greater torque output. The "DM" Brake is a self-energizing, balanced type . . . two identical shoes do an equal amount of work in either forward or reverse direction.

Simple to maintain and adjust. The "DM" Brake is wedge-actuated through an easily accessible operating lever, giving positive braking with immediate response. Can be actuated by either air, hydraulic or mechanical means. Completely accessible for quick, easy adjustment. Simple design keeps service and maintenance to a minimum.

© 1959, R-S Corp.

Another Product of...

ROCKWELL-STANDARD
CORPORATION
Brake Division, Ashtabula, Ohio

FOR EVERY INDUSTRIAL, AGRICULTURAL OR AUTOMOTIVE APPLICATION WHERE BRAKING IS REQUIRED

to protect tubing, threaded or machined parts in process, storage and transit

THERE'S NO BETTER WAY THAN THE CAPLUG* WAY

Over 500 sizes in a dozen different styles carried in stock to meet almost any closure need you can name

* Made of tough, flexible Polyethylene, Caplugs are easy to apply and a cinch to remove. Especially kind to threads and polished surfaces, they won't chip, break, shred or collapse.

Get a kit full of samples in exchange for the coupon attached

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2205-9 Elmwood Ave., Buffalo 23, N.Y.

Mail a free assortment of Caplugs, literature and prices to us, without obligation.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Slots (or corrugations) prevent Fastener from turning.
Sheet remains flush on opposite side. No swaged rim projects.
Clinching ring squeezes sheet material around back-tapered shank, securely locking Fastener.

PEM

The ORIGINAL Self-Clinching Fastener

Fifteen years ago Penn Engineering and Manufacturing Company introduced the self-clinching fastener, providing load-bearing threads in a wide range of—steel, aluminum, brass and copper sheets, "too thin to thread."

THE ANSWER TO PRODUCTION FASTENING

This unique, exclusive design was immediately recognized as the answer to production fastening by leading manufacturers of aircraft and missiles, automotive, electronic and communication equipment, business machines, farm machinery, electrical appliances, transportation equipment, vending machines, home appliances, etc. Stimulated the cost-conscious sheet metal assembly techniques utilized, today, by many of these manufacturers.

INSTALLED BY A SQUEEZE *With the Greatest of Ease* (without special tools)

Users tell us that—because the shank of PEM nuts acts as their own pilot . . . because, being round, they require no indexing . . . because they require no special tools . . . because several may be pressed into place in a single operation . . .

THEY SAVE THEIR COST MANY TIMES OVER

. . . in time, labor and special equipment. PEM nuts are one of the most profitable items in the assembly line.

Today, PEM Self-Clinching Nuts are made in six types for sheet thicknesses from .02″ and up—in steel (with various rust resistant finishes), stainless steel, monel and aluminum. Sizes range from #2 to ¾″. Also made as Blind Fasteners for pressure seal applications.

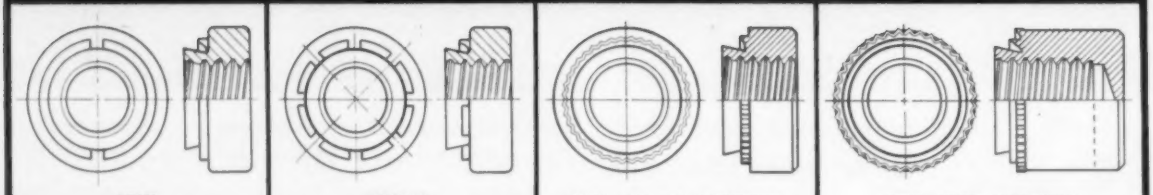
For complete information, write for Bulletin No. CL359.

HIGH TORQUE AND PUSH-OUT RESISTANCE

. . . greatly in excess of assembly handling and screw torquing requirements, insure smooth, fast, uninterrupted fastening procedure. In service, under working load and vibration, torque and push-out resistance are not reliability factors, since the screw is always pulling the PEM Nut toward the sheet into which it is fastened.

The smooth *reverse* side of the sheet, with no swaged rim projecting, permits flush-tight assembly without need for clearance hole in attached part.

SIX TYPES OF PEM SELF-CLINCHING FASTENERS ANSWER MOST ALL REQUIREMENTS



PENN ENGINEERING & MANUFACTURING CORP., DOYLESTOWN • PENNSYLVANIA

New York (Belle Harbor, L. I.)—Neptune 4-7103
Cincinnati—Humbolt 1-4261
Chicago (Forest Park, Ill.)—Forest 6-4971
Indianapolis—Clifford 1-4020
Detroit—University 3-5189
Milwaukee—Bluemound 8-6118
Kansas City, Mo.—Grand 1-6314
Birmingham—State 5-5761
Phoenix—Whitney 5-0680
Dallas—Fleetwood 7-5713
Los Angeles—Bradshaw 2-8097
Miami—Tuxedo 8-4570

CITY ZONE STATE

Current Reprints

Selected articles in recent issues have been reprinted in convenient form for filing. As long as the supply lasts, readers in US and Canada can secure one copy of any of these reprints without charge, by using one of the Reader Service Cards bound inside the back cover. Note that the card must be used within 60 days of publication date. If more than one copy is needed, see price list at end of this listing.

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Filament-reinforced Plastics
Filament-winding method bids for mass-production jobs. July 20 **Circle E 95**

Acoustoelasticity
This important new technique analyzes stress by ultrasonics. July 20 **Circle E 94**

Pressure Losses in Branch Fittings
For hydraulics design, k-factor curves give losses at mainline takeoffs. July 20. **Circle E 93**

Friction Drives
Floating idlers give proper pressure between steel shafts for vibrationless drive. Equations show how to apply them. July 6 **Circle E 92**

Four Ways to Stop a Motor
They range from mechanical to capacitor braking for an induction motor; table shows limitations of each. July 6 **Circle E 91**

Experiments, with Statistical Certainty
What variations in performance to expect for components that will pass production tolerances. July 6. **Circle E 90**

Test Rates Solid Lubricants
How press-fit method works; with list of high-pressure candidates. June 22 **Circle E 89**

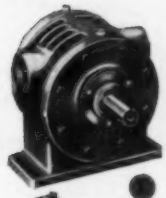
Gearing for Higher Speed Ratios
Novel planetary system does it by pairing helical with spur gears; with design data. June 22 **Circle E 88**

Rating Fluid-control Valves
Author charts directions in which ratings can be simplified and standardized. June 22 **Circle E 87**

Nylon's Tough, New Rival
Design data on a new plastic-rubber blend with similar mechanical properties and lower cost. June 8 **Circle E 86**

Dwell Position of Three-gear Drives
New equations aid in design of this intermittent drive with shockless acceleration. June 8 **Circle E 85**

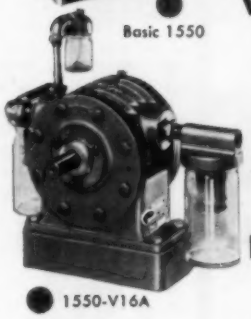
(Continued on page 125)



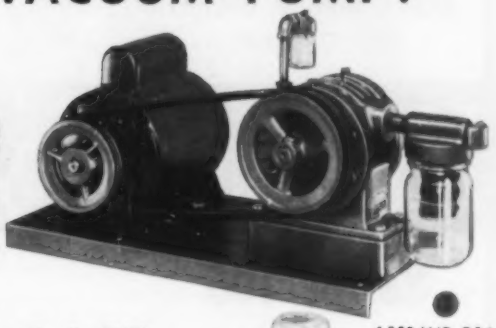
Need an original equipment VACUUM PUMP?

GAST ROTARY AIR PRODUCTS

Basic 1550



1550-V16A



1550-V4D-G34

1550-V48

1550-V105

1550-P41A
Air Compressor

SEE HOW GAST CUTS YOUR COSTS

These pictures demonstrate how *your* product —and cost budget—may benefit when you select Gast rotary Vacuum Pumps for original equipment.

Above (1) is a basic Model 1550 less accessories (one of 13 sizes). For current, active customers, Gast builds this model in dozens of variations. Each one meets specific needs for vacuum, pressure, lubrication, drive method and type of service.

For example, (2) is equipped with wick oiler, and intake and outlet filters for both vacuum and pressure used on paper feeding applications. (3) includes fan-pulley, belt, motor and base as sold for intermittent operation on vacuum-back cameras, vacuum chucks and plastic sheet forming units. (4) has new, large constant-level oiler for rigorous industrial duty. (5) *never* needs oil—has carbon vanes for oil-free air. (6) is a 1550 Model Air Compressor with air intake filter.

As you see, each original equipment buyer gets a job engineered pump. *In the same way, you can save money, because Gast ingenuity—and tooling and manufacturing efficiency—permit precision quality at production prices.*

WRITE FOR FULL DETAILS—REQUEST CATALOG

GAST MANUFACTURING CORP., P.O. Box 117-V Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE OR FLUID POWER DIRECTORY

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

NOW!

An electric counter
that can be
RESET DURING OPERATION
without damage . . .

INTIMEX

Series 100
High-Speed, Quick Reset
Electric Counters

Electrical reset

■ *Here is the ultimate in high-speed electric counters for use in applications demanding speed, accuracy and quick resettability.*

Check these features:

√ Low noise level during operation
√ Large, easy-to-read figures
√ Dust-proof case
√ Instantaneous reset *even during operation*
√ Choice of base or panel mounting
√ Choice of manual or electrical reset
√ Available with 4 or 6 figures

Manual reset

Write for FREE LITERATURE,
INTIMEX CORPORATION Richardson Bldg.
Bonifant & Fenton Sts., Silver Spring, Maryland, (Washington, D.C.)

Sales Engineers in: Worcester, Mass., Hartford, Conn., New York, N. Y., Philadelphia, Pa., Baltimore, Md., Winston-Salem, N. C., St. Petersburg, Fla., Rochester, N. Y., Cleveland, Ohio, Cincinnati, Ohio, Detroit, Mich., Chicago, Ill., Dallas, Texas, Los Angeles, Cal.

120 CIRCLE NO. 120 READER SERVICE CARD

HERE'S UNDISPUTED PROOF
FROM ENGINEERS WHO KNOW

up to 25% reduction in piston travel with Clinton Engines

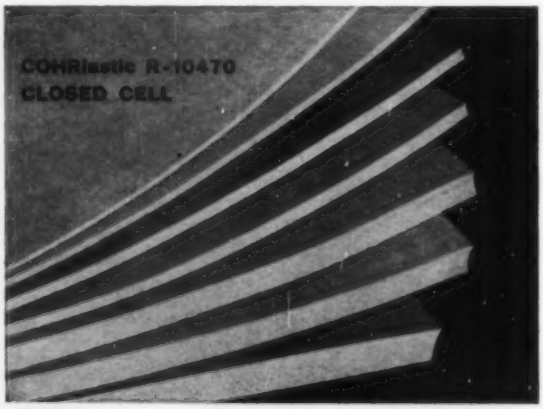
The important thing is that you prove this fact to yourself. The features of *any* engine mean nothing until *you* have proved them to your own satisfaction and believe them to be fact. That's why Clinton invites you to make your own grueling torture test on any Clinton Engine mentioned below. We want you to prove to yourself beyond question that a Clinton Engine lasts longer. Write Clinton to make arrangements for an engine torture test.

TAKE A LOOK AT THE PROOF FOUND IN ACTUAL COMPARATIVE TESTS

	Clinton A1690	"A"	"B"
Piston Displacement	16.3	14.88	14.21
Bore	2 13/16	2⅝	2⅝
Stroke	2⅝	2¼	2⅝
RPM @ 4½ Net BHP—70 lbs. PSI	3124	3422	3583
FPM Piston Travel	1367	1568	1568
Reduction in FPM @ 4½ HP	13%	X	X

CLINTON ENGINES CORPORATION
(Formerly Clinton Machine Company)
Engine Division • Dept. 174-C • Maquoketa, Iowa

CIRCLE NO. 208 READER SERVICE CARD



Silicone Sponge Rubber

flexible at temperatures —100°F to 500°F

COHRlastic R-10470 has a dense, uniform, non-absorbing closed cell structure, highly suitable for soft gasketing, vibration dampening, fairing strips, pads, cushions and other applications where resiliency at extreme temperatures is required. It may be bonded to metals, plastics, fabrics or silicone rubber. Possesses superior compression set resistance, excellent dielectric properties, immunity to aging, ozone and weather hardening. Available from stock in 24" x 24" sheets —1/16" through 1/2". Special sizes and extruded shapes made to order.

FREE SAMPLES and folder — write, phone or use inquiry service.

CHR PRODUCTS: COHRlastic Aircraft Products — *seals, coated fabrics, and ducts;* COHRlastic Silicone Rubber Products — *moldings and extrusions, sheets and sponge;* Temp-R-Tape — *pressure sensitive, thermal curing Teflon and silicone tapes;* Allied Products — *COHRlastic silicone cements and conductive gasketing.*

CHR CONNECTICUT HARD RUBBER
Main Office: New Haven 9, Connecticut

CIRCLE NO. 209 READER SERVICE CARD

Current Reprints .....continued

Roundup of Assembly Methods
16 pages of illustrated how-to's on all the ways to put parts together, distilled from previous articles in Product Engineering. June 8 Circle E 84

For a Tight-gasketed Joint
Gasket behavior with different flange metals and fluctuating temperatures; detailed design recommendations. May 25 Circle E 83

Batteries for Higher Energy
Can power packs become $\frac{1}{10}$ as heavy as the best now available; where to look for improvements. May 25 Circle E 82

Gear Tolerances
A gear-maker's suggestion for a workable approach to new precision standards meeting users' needs. May 25. Circle E 81

Shock Tests for Rough Handling
How they work and how to apply data in design. May 11 Circle E 80

Buckling in Hydraulic Tubing
How to design against the chance that a straight run will buckle under fluid pressure. May 11 Circle E 79

Edge of the Unknown
Forecast of what tomorrow's producers, power sources and thinking machines will look like. May 4 Circle E 78

QUANTITY PRICES

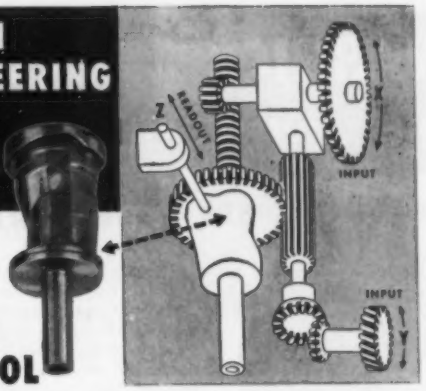
For single shipments of any one title to one address on order accompanied by remittance, quantity orders will be supplied at the following prices as long as the supply lasts.

Quantity	Price per Copy
5	$0.25
25	0.20
50	0.15
100	Write for quotation

Make checks payable to PRODUCT ENGINEERING, 330 West 42nd St., New York 36, N. Y.

DESIGN ENGINEERING with Parker

3-D CAM CONTROL



With X and Y, the input variables of temperature, r.p.m., pressure, speed, magnetic force, liquid flow, altitude and many other factors—progressive Design Engineers have added *mechanical reliability* to vital control functions.

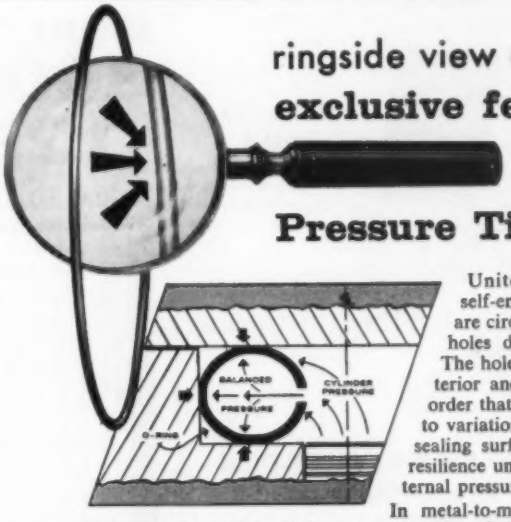
The flawless functioning of a dive bombing ballistics' computor—a navigation control that compensates for irregularities in the earth's magnetic lines of force . . . these are but two of the demanding requirements where mechanical control offers advantages.

If mechanical reliability—fidelity of readout under severe environmental extremes—smaller control size—lighter control weight promises advantages in your control problem, we suggest you consider a Parker 3D Cam.

Send for this fully illustrated brochure today!

THE PARKER-HANNIFIN CORPORATION 17 FRANKLIN AVENUE HARTFORD CONNECTICUT

CIRCLE NO. 210 READER SERVICE CARD



ringside view of United's **exclusive feature** for

Pressure Tight Seals

United's exclusive, patented* self-energized metallic O-rings are circular tubes vented by tiny holes drilled in the ring wall. The holes are to balance the interior and exterior pressures in order that the ring may respond to variation in deflection of the sealing surfaces with a natural resilience uninhibited by the external pressure.

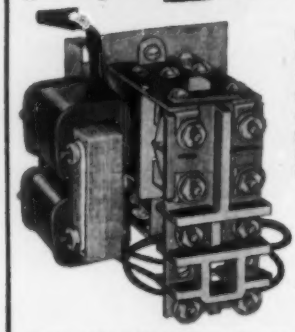
In metal-to-metal applications, self-energized metallic O-rings are capable of forming positive, permanent, non-corrosive static seals under extreme temperatures from —321°F. to 1800°F., and under pressures equal to ultimate compression stress of the metal itself. Available in various metals and finishes, 3/8" dia. to any size or configuration. United also makes non-vented and pressure-filled O-rings; and wire and brazing O-rings. Write for free 22-page booklet (on your letterhead please).

PATENTS 2,809,269; *2,837,360

UNITED METALLIC "O" RING CORP.
Dayton, Ohio • Box 1035
Division of United Aircraft Products, Inc.

WARRICK Floatless Electrode Type LIQUID LEVEL CONTROLS . . .

give you all these advantages!



No moving parts in the liquid • Easy to install • No adjustments necessary • Unaffected by acids or caustics • Unaffected by pressure or temperature • Standard 2&3 pole units listed by U/L

Write for 32-page Catalog which gives complete specifications

Two pole control shown at left

YOU CAN USE OUR CONTROLS FOR:

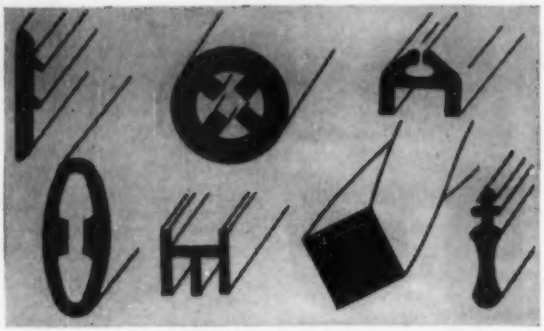
- Single & multiple pumps
- Motor & solenoid valves
- High & low cutoffs & alarms
- Sewage & waterworks
- Chemical Industries
- Food & Dairy Industries
- OEM applications

Special controls to custom requirements

CHARLES F. WARRICK CO.
1964 W. Eleven Mile Road, Berkley, Michigan
Dept. 3 Telephone JOrdan 4-6667

CIRCLE NO. 211 READER SERVICE CARD

ACE PLASTIC EXTRUSIONS



SHAPES • CHANNELS • SPLINES • PROFILES
CORNER MOLDINGS • RODS • TUBES
IN THESE PLASTICS
ACRYLICS • ACETATE • BUTYRATE • POLYCARBONATE
POLYPROPYLENE • METHYL STYRENE • ETHYL CELLULOSE
POLYETHYLENE • STYRENE • VINYLS-ELASTOMERIC & RIGID

FAST DELIVERY

Write, wire, phone for Bulletin ES, samples and prices or send specifications, blueprints for immediate quotation.

ACE PLASTIC COMPANY
91-56 Van Wyck Expwy., Jamaica 35, N. Y. JAmaica 3-5500

CIRCLE NO. 212 READER SERVICE CARD

LECTROETCH VT-15-A POWER UNIT

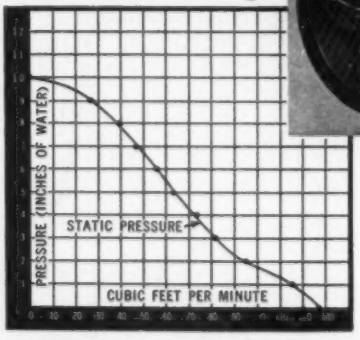
TRADE MARKS • PARTS IDENTIFICATION
fast, deep, stress-free marks . . .

Use this new variable-potential power source for uniform, deep-etched marks that resist wear . . . and that must penetrate or show through surface treatments. This high-production process gives you faithful reproduction with no stress or strain in even the most delicate parts.

REQUEST DETAILS TODAY!

The LECTROETCH Co.
14925 Elderwood Ave., East Cleveland 12, Ohio

MORE THAN 3000 HOURS at 125°C ...and still running!



NEW Tube, Axial Blower

Here's a miniature tube axial blower that withstands the most rigid MIL specifications! Tests at 125°C and under extreme shock and vibration conditions, have exceeded 3000 hours, with no sign of failure. The motor is EAD's rugged, 400-cycle 208-volt induction motor, run at a constant speed of 7200 rpm. Write for complete information on this peak-performance blower assembly.

EAD EASTERN AIR DEVICES, INC.
Subsidiary of Norbute Corporation
381 CENTRAL AVE., DOVER, NEW HAMPSHIRE

CIRCLE NO. 213 READER SERVICE CARD

CIRCLE NO. 122 READER SERVICE CARD

NEW!

COMPRESSION and EXTENSION SPRING TESTER FROM CHATILLON

The new Chatillon MST Spring Tester is COMPACT, EFFICIENT, ACCURATE (accurate to within one graduation)

FEATURES OF THE MST SPRING TESTER

- TESTS BOTH EXTENSION AND COMPRESSION SPRINGS
- ACCURATE TO WITHIN ONE GRADUATION
- COMPACT — INEXPENSIVE
- EASY TO USE — RACK & PINION DRIVE LOCKS LOAD AUTOMATICALLY AT ANY POINT
- 5% TARE ADJUSTMENT
- TEMPERATURE COMPENSATED CHATILLON TEMPRUF® SPRINGS
- AVAILABLE IN CAPACITIES RANGING FROM 5 lbs. x .02 lbs. to 500 lbs. x 1 lb.

WRITE FOR FREE LITERATURE TODAY

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK 38, N.Y.
Manufacturers of Scales, Force Measuring Instruments and Precision Springs
Since 1835

CIRCLE NO. 214 READER SERVICE CARD

DESIGN ABSTRACTS

Applying Differential Equations to Induction-motor Transients

Equations are provided for solutions on either analog or digital computer that can be used to: 1) generate motor's dynamic and steady-state speed-torque capability curves; 2) predict acceleration time; 3) show response to impact loading; 4) illustrate reaction to line-voltage fluctuations; 5) speed-torque curves for wound-motor action.

"Applying Differential Equations to Induction Motor Transients," H S Neuville, Allis-Chalmers Electrical Review, 1st Quarter, Milwaukee 1.

Effect of Stress Cycling on Static Properties of SAE 4340 Steel

Previous investigations have been confined to effect of stress cycling on dynamic properties. Heat-tested specimens were cycled under axial tensile loading to various percentages of fatigue life for stress level selected. From stress-strain curves obtained, various tensile mechanical properties were determined and compared with property values for specimens not subjected to initial cycling.

"Effect of Stress Cycling on Static Mechanical Properties of SAE 4340 Steel," Marin, Borachia and Rimrott, Pennsylvania State University. Presented at 62nd Annual Meeting of ASTM, June 21-26. 1916 Race St, Philadelphia 3.

Drawing and Rolling Metals in Liquidmeter Pressure

Apparatus based on initial investigations by Bridgman and extended by authors consists of free-running rollers used to draw or form metals under hydrostatic pressures up to 10,000 kg/cm². Liquid was pressurized by laboratory compressor rated at 3.8 liter/hr. Installation was used for experiments in forming and drawing to various degrees of deformation and although authors note improved properties, detailed results are not given.

"Apparatus for Drawing of Metals and Rolling Them with Free-running Rollers in Liquid Under High Hydrostatic Pressure," B I Beresnev and others. Tsvetnye Metally, USSR, March 1959. Translation available from Henry Brutcher, P O Box 157, Altadena, Calif.

LATCHES

outstandingly different

- over-the center positive action
- flush when closed
- seals against internal and external pressure
- protects against dirt and moisture
- fail-safe construction
- aromatic fuel resistant
- 1 to 1-¾ oz. weight

Missile-Air latches are in use on jet aircraft, missiles and electronic equipment under the most severe environmental conditions. They cannot fail under stress or vibration. Fingertip opening or closing without tools greatly speeds servicing. *Sensibly priced for any application.* Many types to choose from or special design on request.

Send for complete technical information to:
1700 Rosecrans Boulevard,
Manhattan Beach, California.

Missile-Air

A Division of United States Chemical Milling Corporation.

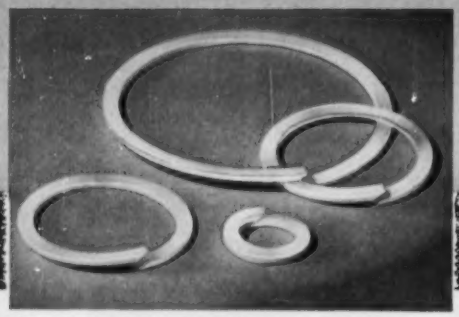
CIRCLE NO. 123 READER SERVICE CARD

PRECISION

H·I·S TEFLON*

for LIFE-TIME & TROUBLE-FREE

HYDRAULIC SERVICE

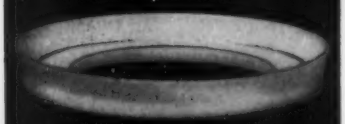


Single Turn Back-up RINGS . . .

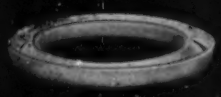
ALL THE NEW MILITARY SIZES — MS-28774, MS-28777 and MS-9058.

Accurately machined to assure you the fullest utility range and life of your equipment.

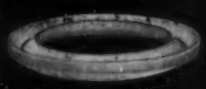
Only **HALOGEN** *offers* **"MEMORIZED" TEFLON**



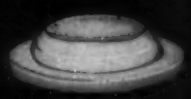
Style 310 Piston Cups



Style 614 V Rings



Style 410 U Cups and Blocked Vees



Style 210 Flange Seals

Halogen cylinder packing is known for operating successfully and efficiently over the widest temperature and pressure ranges . . . because they are "MEMORIZED".

This is an EXCLUSIVE process which makes the packing lip "remember" the size of the rod or cylinder . . . and keeps it in sealing position, regardless of temperature variations.

Send your prints for assembly details and find out about FIELD PROVEN AND ENGINEERED "TEFLON by HALOGEN."

Write for complete catalog on "TEFLON HYDRAULIC SEALS" . . . it's FREE!

HALOGEN

INSULATOR & SEAL CORP.

5600 Pacific Avenue, Franklin Park, Illinois, GLadstone 5-9000

Engineers and manufacturers of products of TEFLON DuPont T.M.

You Get MORE with

DOERR MOTORS

QUALITY . . . Top performance and life.

APPEARANCE . . . Compliments your product.

DESIGN SERVICE . . . Solves toughest problems.

COOPERATION . . . Even on small-lot orders.

YOUR PRODUCTS are *easier to produce . . . easier to sell . . .* with a Doerr motor as original equipment.

Got a problem? Doerr's experience with thousands of "specials" suggests quick, economical answers. Our broad background helps develop practical new designs to fit all of your requirements at lowest cost.

Also, Doerr quality construction assures full performance of your product . . . while compact, modern Doerr styling adds to appearance.

CALL DOERR WHEN YOU NEED MOTORS

On your next call for motors, get MORE . . . contact DOERR! Expanded line includes ratings from 1/30 to 15 hp. Specials are our *specialty*—backed by nation-wide, expert field service. Phone Cedarburg 801 or write . . .

DOERR ELECTRIC CORPORATION

93 N. FOURTH AVE. • CEDARBURG, WIS.

CIRCLE NO. 215 READER SERVICE CARD

molded *Black Nylon* **screws and nuts**

Insulate and Fasten without bushings, washers, etc. In Stock 2-56, 4-40, 6-32, 8-32, 10-32 and ¼-20.

See us at Booth 1017 Wescon Show—San Francisco

Black Nylon **"NyGrip" cable clips**

Light-weight non-conducting support for wiring, tubing, etc. In Stock 1/16" to 1½" Dia.

Free samples • write **WECKESSER CO.**

5705 Northwest Highway, Chicago 46, Ill.

CIRCLE NO. 216 READER SERVICE CARD

EMPLOYMENT OPPORTUNITIES

OPPORTUNITIES . . .

With

A

Growth Company

A progressive, rapidly expanding manufacturer in the field of xerography — a method of physical photography based on solid state and electrostatic phenomena — has openings for:

PRODUCT ENGINEER — M.E., E.E., or I.E. with 3-5 years' experience. Must have knowledge of capabilities of machine manufacturing processes and economical machine design.

PROCESS ENGINEER — M.E. with 5 years' experience in machine tools and processes. Will investigate new manufacturing processes and equipment, prepare recommendations for the purchase of machine tools and aid in developing tool engineering standards.

MANUFACTURING STANDARDS PLANNER — M.E. or equivalent in experience with 3-5 years background in preparing manufacturing engineering standards and standardization of tools and tool components.

Kindly send resume and salary requirements to

FRED A. WETERRINGS
Industrial Relations Division

HALOID XEROX INC.
2-20 Haloid Street
ROCHESTER 3, NEW YORK

CHIEF ENGINEER
$18,000 to $20,000

Our client, a multi plant operation, needs divisional chief engineer. Client is a leading manufacturer of consumer products. I.E. circuit breakers, power transmission equipment, molded cases and associated switch gear. Will supervise engineering effort of 40 men in design and development of the above mentioned equipment.

ESQUIRE PERSONNEL
202 S. State Street Chicago 4, Ill.

NEW BOOKS

Heat Transfer to Boundary Layers

SEBAN and CHAN. PB 151414 (WADC Technical Report 57-111). Armed Services Technical Information Agency (ASTIA), Arlington Hall Sta, Arlington 12, Va. 8¼ x 10½, 88 pp. $2.25.

This is a report of the work completed on two contracts dealing with the prediction of heat transfer to laminar and turbulent boundary layer flows under conditions of variable free stream velocity. Particular emphasis was directed toward experimental data which could be used as the basis for methods of prediction. A few methods showing typical approaches to the problem were reviewed and checked by experimentation.

When flow is laminar and properties are variable, the report shows that prediction methods become complex and a specific comparison with experimentation is not possible. However, if the problem is simplified, such as assuming constant temperature at the wall and a continuously-accelerated flow, simple methods intended for constant-property flow are found to be adequate for high Mach numbers.

Preferred methods for both laminar and turbulent flows are presented with detailed sample calculations to serve as a guide for their application.

1958 Book of ASTM Standards

American Society for Testing Materials, 1916 Race St, Philadelphia 3. 10 vol, $116.

All 10 volumes of the 1958 Book of ASTM Standards have recently been published. Distributed throughout the world, ASTM standards are used to cover the production, purchase, and evaluation of millions of dollars worth of materials annually. The increase from 7 to 10 volumes in 1958 was necessitated by a growth in size of individual parts to the point where they could no longer be bound economically and were becoming unwieldy in size.

Within the 10 parts are contained 2450 standard specifications, methods of test, definitions of terms, and recommended practices. These will oc-

(Continued on page 127)

Strataflo
SPECIAL
CHECK VALVES
for
Submersible
Pumps

SILICONE TREATED RUBBER POPPET

Tapped one or two holes for attaching Pressure Switch, Pressure Gauge or Snifter Valve.

No. 350

Here's the answer to your Check Valve problems on submersible pumps. The taper-type rubber poppet is noiseless, does not leak, opens easily. Works in any position.

All bronze body. Five sizes, ⅜" through 2". May be tapped for one or two side connections as shown. Used as original equipment by many leading pump manufacturers.

Write today for Bulletin 203, or telephone Harrison 3313 for more information.

STRATAFLO PRODUCTS, INC.
FORT WAYNE, INDIANA

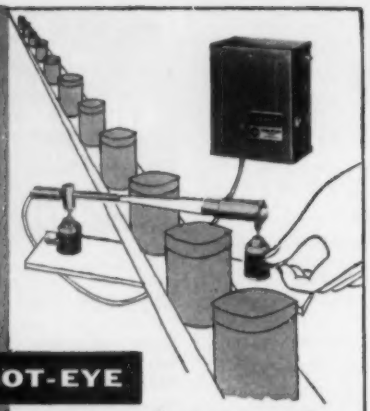
CIRCLE NO. 125 READER SERVICE CARD

Get the greatest benefit from Product Engineering by having your own subscription.

Each week you can then read the articles and advertisements at your convenience—and set up your own information file. *Use subscription card in back of this issue or write direct to:*

Circulation Manager
Product Engineering
23rd Floor
330 W. 42nd St.
New York 36, N.Y.

versatile, miniaturized, low-cost photo-electric control



ROBOT-EYE

counts, sorts, inspects

RE-2 (2 pc. unit, no counter)	$44.50
RE-3 (3 pc. unit, no counter)	65.00
RE3-C4 (with 4-digit counter)	84.00
RE3-C6 (with 6-digit counter)	88.00

Accurate – follows most rapid operations.
Trouble-Free – Proven for years in industry.
Easily-Installed – with universal mount.
Miniaturized – for use in smallest space.

To learn how Robot-Eye can help cut your production costs, write for Brochure HP-7.

standard
INSTRUMENT CORP.
657 BROADWAY
NEW YORK 12, N.Y.

CIRCLE NO. 217 READER SERVICE CARD

PROBLEMS?

They'll be eliminated when you ask

JOHNSON

for your

RUBBER, PLASTIC AND SILICONE EXTRUDED AND MOLDED PARTS

Have your problems—heat, cold, color, oil resistance, and close tolerance—solved by experts.

Two plants with complete facilities for designing, compounding and finishing, to your specifications.

Convenience: Branch offices in leading cities for personal service.

Products finished to Commercial and Government Specifications

Write today for additional information

SPECIALISTS IN COMPLICATED SHAPES

JOHNSON RUBBER COMPANY
MIDDLEFIELD, OHIO ESTABLISHED 1895

JOHNSON PLASTIC CORP.
CHAGRIN FALLS, OHIO

CIRCLE NO. 218 READER SERVICE CARD

AWICA STANDARD AND SPECIAL CLAMPS AND SEALS

Ready availability of this complete line of proven clamps and couplings makes AWICA one of America's superior sources. AWICA clamps have exclusive "hook-bolt" feature assuring positive locking and superior holding strength – yet at lighter weight. In use in extreme temperature, high pressure application. Your inquiry invited – Write for Literature.

AWICA
12177 Montague St., Pacoima, Calif
a division of POLY INDUSTRIES

THE ENGINEER'S BOOKSHELF

is a carefully screened listing of all published reference books for engineers.

Updated to include books published in 1957 and 1958, it now includes the

- **20 best handbooks**
- **542 basic references in 22 specialized fields**
- **161 technical periodicals published by manufacturers, the trade press, technical societies, universities and the government.**

This 16-page report is yours for just 25¢. Order it by writing.

READERS SERVICE MANAGER
Product Engineering
330 West 42nd Street
New York 36, N. Y.

cupy 13,600 pages. Each volume is complete with a detailed index and a list of standards in numeric sequence. To keep this book up to date, supplements will be issued to each part late in 1959 and 1960.

Those volumes applicable to the OEM are:

Part I–Ferrous Metals Specifications (except test methods) 1560 pp, 290 standards (Jan 1959) $12; Part II –Non-Ferrous Metals Specifications (except test methods), Electronic Materials, 1386 pp, 251 standards (Oct 1958) $10; Part III–Methods of Test for Metals (excluding chemical analysis), 980 pp, 119 standards (Dec 1958) $10; Part 5–Masonry Products, Ceramics, Thermal Insulation, Sandwich and Building Constructions, Acoustical Materials, Fire Tests, 1176 pp, 226 standards (Jan 1959) $12; Part 6–Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather, 1152 pp, 210 standards (Feb 1959) $10; Part 7–Petroleum Products, Lubricants, Tank Measurements, Engine Tests, 1420 pp, 227 standards (Dec 1959) $12; Part 8–Paint, Naval Stores, Aromatic Hydrocarbons, Coal, Coke, Gaseous Fuels, Engine Antifreezes, 1424 pp, 353 standards (Feb-March 1959) $12; Part 9–Plastics, Electrical Insulation, Rubber, Carbon Black, 1680 pp, 290 standards (Dec 1959) $14.

Thermodynamics

Gordon J Van Wylen. Published by John Wiley & Sons Inc. 440 Fourth Ave, New York 16. 6 x 9, 567 pp. $7.95.

The author combines engineering, mathematics and easy-to-understand writing style to personalize the much-covered subject of thermodynamics. The first chapter briefly describes a steam power plant, a refrigerator, a gas turbine and a liquid-propellant rocket. After this appetizer, the book plunges into definitions and terminology, but with a new twist: symbols distinguish between 'mass' and 'force.' For example, acceleration due to gravity, g_c, is defined as 32.174 lbm-ft/lbf-sec^2. The next two chapters are involved with preliminary-type information: properties of pure substances, work and heat. Chapter 5 and the remaining ones are typical "thermo" and cover the first law, second law, entropy, ideal gases, mixtures, availability, irreversibility, efficiency, reciprocating machines, power, refrigeration, nozzles, thermodynamic relations, combustion and equilibrium. The appendix describes theory of "control volume" and gives tables of thermodynamic properties.

Other Books of Interest

Space Guide.

V F Callaham Jr, Editor. Washington Space Letter, 1420 New York Ave, NW, Washington 5, DC. 8½ x 11, 174 pp. $10.

Discusses research, development, production, procurement activities of the National Aeronautics & Space Administration in an attempt to provide manufacturing firms, research organizations and educational institutions with authoritative information on this agency's activities and needs.

Big Molecules.

Sir Harry Melville. Macmillan Co, 60 Fifth Ave, New York 11. 7½ x 5, 180 pp. $3.95.

Discusses chemistry of high polymers which has resulted in such new products as ion-exchange resins, adhesives, electrically-conductive rubbers, permanent lubricants.

Standard Method of Test for Adhesion of Printed Wiring, EIA Standard RS-216.

Engineering Dept, Electronic Industries Assn, 11 W 42nd St, New York 36. 8½ x 11, 5 pp.

DURA SEAL
The PERFECT SEAL
ROTATES WITH THE SHAFT

MEANS RELIABILITY IN MECHANICAL SEALING

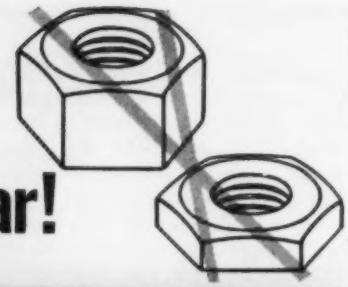
"THE ENGINEERED MECHANICAL SEAL"

because Dura Seal is backed by 25 years of experience — because Dura Seal is supported by continuous research for meeting modern processing demands — because Dura Seal is engineered to meet your specific operating conditions — because Dura Seal is nationally sold and serviced.

For Free Engineering Counsel on Your Sealing Problems, write DURAMETALLIC CORP., Kalamazoo, Michigan

CIRCLE NO. 127 READER SERVICE CARD 127

Save 65¢ on each Fastener Dollar!



Replace expensive heavy nuts and jam nuts with low-cost, vibration-proof

PALNUT TYPE R LOCK NUTS

All PALNUT Lock Nuts provide attractive savings—but in sizes from ⅜" and up, the ratio of economy increases dramatically. On many applications, Type R PALNUT Lock Nuts can do the job better, at ⅓ the price! PALNUT spring-tempered steel lock nuts provide rugged assembly for loads in shear and moderate tensile loads, in sizes up to 2½" diameter. In addition, you get the following design and cost advantages:

- Vibration-proof assemblies without lockwashers.
- Save Space—need only 3 bolt threads, permit shorter bolts.
- Save Weight—PALNUTS weigh 65% less than plain nuts, 80% less than plain nut and lockwasher.
- Precision Made—always fit screw threads.
- Fast Assembly with hand or power tools.
- Sizes from #3-48 Machine Screw through 2½" American Standard Heavy.

Above: A 7/16"-18 PALNUT securely fastens inlet nipple in airplane brake assembly.

Right: A ¾"-20 PALNUT used on base assembly of food mixer.

Above: A 1"-14 PALNUT holds rear view mirror bracket to cowl of automobile.

Write for literature and free samples, stating type, size and application.

THE PALNUT COMPANY, 65 Glen Road, Mountainside, N. J.
In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS

Quick, secure fastening at low cost

Index of PRODUCTS ADVERTISED In This Issue

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD.

A

Accumulators 91
Adhesives 107
Air Motors (see Motors, Air)
Aluminum Alloys 115

B

Bearings
  Roller ..... 4th Cover
Belts, Timing 105
Belts, V 70, 96
Blowers 122
Bolts 102
Boosters 91
Brakes
  Hydraulic 116
  Mechanical 116
  Pneumatic 116
Brass 39
Bronze 39

C

Cams 121
Castings 94
Chains
  Conveyor 105
  Roller 11, 92, 105
  Silent 105
Chemical Treatments 29
Clamps 126
Clips, Electrical 124
Closures 117
Clutches
  Mechanical 86-87
Coatings 29, 100
Compressors 119
Connectors
  Hose 15, 80, 108
  Tube 15, 80, 108
Controls
  Electrical 84-85, 109, 126
  Electronic 84-85
  Pneumatic 75, 131
Cork Compositions 14
Counters 120
Couplings (see Connectors, Electrical)
Cylinders
  Hydraulic 32, 42-43, 91, 111
  Pneumatic 42-43, 91, 111, 131

D

Drafting
  Supplies 65
Drives
  Variable Speed ..... 3rd Cover

E

Electrochemical Finishes & Treatments 100
Engines 120
Expanded Metals 101
Extrusions
  Metallic 4, 39
  Nonmetallic 122

F

Fabricated Steel (see Sheet Fabricated, Structural Forms & Shapes, Weldments)
Fastening Methods ... 33, 44, 77, 78, 82-83 89, 102, 118, 128
Fibre 110
Finishing Equipment & Supplies 2
Fittings, Hose, Pipe & Tube 15, 80, 88, 108
Flexible Couplings 92
Forgings 39

G

Gaskets 14, 110
Gear Motors (see also Motor Reducers) ..... 3rd Cover
Gears 76

H

Heating Units 114
Hose & Tubing 35, 88

I

Instruments
  Mechanical 123

J

Jacks 95
Joints
  Swing & Swivel 108

Index of

PRODUCTS ADVERTISED

In This Issue

L

Laminated Plastics (see Plastics, Laminated)
Latches 123
Liquid Level Controls 122
Locks 128
Lubricating Equipment 75

M

Marking Machines & Tools 122
Moldings
Plastics (see Plastic Parts)
Rubber (see Rubber Parts)
Motor Starters 68
Motors, A-C
Fractional ..3rd Cover, 40-41, 68, 84-85 93, 124
Integral .....3rd Cover, 40-41, 68, 124
Sub-Fractional 84-85, 110
Motors, Air 119
Motors, D-C
Fractional.....3rd Cover, 40-41, 68 84-85, 93
Integral .....3rd Cover, 40-41, 68
Sub-Fractional 84-85
Motors, Hydraulic 32

N

Nickel Alloys 2
Nuts.....33, 37, 44, 118, 124, 128

P

Packings 114, 124
Photographic Equipment
Film 10, 65, 97
Plastic Parts 122, 126
Plastics 30-31, 113
Plastics Laminated 103
Programmers 127
Pumps
Air 119
Liquid 32, 72, 106
Vacuum 119

R

Regulators
Pneumatic 75
Relays 81, 84-85
Reproduction Equipment 129
Reproduction Supplies 65, 129
Rivets 33, 78, 89
Rubber 34
Rubber Parts 126, 132

S

Screws 82-83, 106, 124
Seals.....2nd Cover, 99, 106, 114 121, 124, 126
Sheets
Metal 27
Silicone Rubber 120
Silicones 17-18
Special Shapes & Sections 39
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) ... 33 37, 44, 78, 118
Speed Increasers & Reducers 28
Springs 123
Sprockets 11, 105
Steel
Alloy 8-9
Stainless 27
Strip, Metallic 27
Switches 130

T

Tapes 103
Thermostats 6, 38
Timers 109
Tubes 112
Tubing
Coated 12-13
Flexible Metal 15
Lock-Seam 104
Seamless 4, 104, 112
Welded 4, 12-13

V

Valves
Air 1, 42-43, 79, 125, 131
Control 131
Hydraulic 32, 42-43, 79
Solenoid 1, 79, 98

W

Welding
Equipment 36
Nuts 106
Supplies 36
Weldments 90
Wire Cloth 16

ALL NEW! BRUNING COPYFLEX 435

IT HAS EVERYTHING EXCEPT A HIGH PRICE!

Here, without question, is the greatest value in reproduction today!

Bruning's Copyflex 435 is a completely new medium-volume machine that offers you all the conveniences of most big-production machines but a an amazing low price!

It has a spacious 42" printing width, powerful 3,000* watt lamp, and a mechanical speed of 40 feet per minute . . . plus a host of such conveniences as automatic separation, a foot lever for releasing incorrectly fed stock, adjustable front print tray, automatic tracing stacker, new air filtering system that assures cleaner prints, and a pressure-roller developer system that provides positive print development at all speeds. The 435 is fully equipped for roll stock. It provides selective front or rear print delivery.

Like all Copyflex machines, the 435 is odor-free, requires no venting, plumbing, or auxiliary equipment. Built by Bruning, it offers the durability and dependability that Bruning machines are famous for. You have ***everything*** to gain by investigating now the whiteprinter that gives you ***everything*** at the lowest price ever!

*4,000 watt lamp optional.

BRUNING Copyflex® Low Cost Diazo Reproduction at It's Best!

The Bruning Man is your expert on diazo reproduction. He's backed by a company with over 60 years' experience.

Charles Bruning Company, Inc. Dept. 7-W
1800 Central Rd., Mt. Prospect, Illinois

Offices in Principal U. S. Cities
In Canada: 103 Church St., Toronto 1, Ont.

Please send me more information on the new Copyflex Model 435.

Name_____ Title_____

Company_____

Address_____

City_____ County_____ State_____

For remote control switching jobs . . .

stepping, counting, programming,

circuit selecting, sequencing and homing

I specify

LEDEX SELECTOR SWITCHES

because...

sizes from sub-miniature, with
switch positions to meet all requirements
any operating voltage from 3 to 300 volts DC
variety of models stocked for immediate delivery
hermetically sealed models are offered
compactness eliminates "bulk" problems
silver alloy contacts give long switch life
the economical solution to multiple circuit switching
experienced LEDEX engineers are available to help
LEDEX means dependability
write for descriptive literature today!

LEDEX

G. H. LELAND, INC.
DAYTON 2, OHIO, U.S.A.

In Canada: Marsland Engineering, Ltd., Kitchener, Ontario
In Europe: NSF Ltd., 31-32 Alfred Pl., London, England; NSF, GmbH, Nürnberg, Germany

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Ace Plastics Co. 122
Acme Chain Corp. 92
Allied Research Products, Inc. 29
American Brass Co. 39
American Cast Iron Pipe Co. 112
American Engineering Co., Hydraulic Pump Div. 72
American Metal Hose Div., American Brass Co. 15
Anchor Coupling Co., Inc. 80
Angier Adhesives Div., Inter-chemical Corp. 107
Armco Steel Corp. 12-13
Armstrong Cork Co. 14
Automatic Switch Co. 79

Babcock & Wilcox Co., Tubular Products Div. 4
Barber-Colman Co. 84-85
Beattie-Coleman, Inc. 127
Blaw-Knox Co. 94
Bruning Co., Inc., Charles 129

Cambridge Wire Cloth Co. 16
Chatillon & Sons, John 123
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Clare & Co., C. P. 81
Clinton Engines Corp., Engine Div. 120
Commercial Shearing & Stamping Co. 32
Connecticut Hard Rubber Co. 120
Cone-Drive Gears Div., Michigan Tool Co. 28
Continental Diamond Fibre Co., Subs., Budd Co. 103
Controls Co. of America 109

Detroit Controls Div., American Radiator & Standard Corp. 98
Doerr Electric Corp. 124
Dow Chemical Co. 30-31
Dow Corning Corp. 17-18
Duff-Norton Co. 95
Durametallic Corp. 99
du Pont de Nemours & Co., (Inc.), E. I., Film Dept. 10

Eastern Air Devices, Inc. 122
Eastman Mfg. Co. 108

Fenwal, Inc. 6
Firestone Steel Products Co., Div., Firestone Tire & Rubber Co. 115
Formsprag Co. 86-87

Gast Mfg. Corp. 119
Gates Rubber Co. 96
General Industries Co. 110
Goodrich Co., B. F. 33
Great Lakes Steel Div., National Steel Corp. 8-9
Greene, Tweed & Co. 114

H & H Tube & Mfg. Co. 104
Halogen Insulator & Seal Corp. 124
Hotwatt, Inc. 114
Huck Mfg. Co. 102

International Nickel Co., Inc. 2
Intimex Corp. 120

Johnson Rubber Co. 126

Keuffel & Esser Co. 65

L & L Mfg. Co. 106
Lamb Electric Co. 93
Lectroetch Co., The 122
Leland, Inc., G. H. 130
Linde Co., Div. of Union Carbide Corp. 36
Link-Belt Co. 11

McLouth Steel Corp. 27
MacLean-Fogg Lock Nut Co. 37
Mahon Co., R. C. 90
Metal & Thermit Corp. 100
Metals & Controls, A Div. of Texas Instruments, Incorporated 38
Michigan Tool Co., Cone-Drive Gears Div. 28
Miller Fluid Power Div., Flick-Reedy Corp. 91

INDEX TO ADVERTISERS

Minnesota Mining & Mfg. Co., Chemical Div. 34
Missile-Air, Div., U. S. Chemical Milling Corp. 123
Morse Chain Co., A Borg-Warner Industry 105

Ohio Nut & Bolt Co..... 106
Ohio Rubber Co..... 132
Ortman-Miller Machine Co..... 111

Palnut Co. 128
Parker-Hartford Corp. 121
Parker-Kalon Div., General American Transportation Corp. 82-83
Penn Engineering & Mfg. Corp..... 118
Penn Metal Co., Inc..... 101
Perkins Machine & Gear Co..... 76
Poly Industries .. 126
Protective Closures Co., Inc..... 117

Randolph Co., The..... 106
Recordak Corp., Subs., Eastman Kodak Co. 97
Reliance Electric & Engineering Co. .....3rd Cover
Robbins & Myers, Inc.....40-41
Rockwell-Standard Corp., Brake Div. 116
Rohm & Haas Co..... 113
Ross Operating Valve Co..... 1

Shakeproof Div., Illinois Tool Works 77
South Chester Corp., Southco Div... 78
Standard Instrument Corp..... 126
Stewart Warner Corp., Alemite Div. 75
Stratoflo Products, Inc..... 125

Timken Roller Bearing Co.....4th Cover
Tinnerman Products, Inc..... 44
Titeflex, Inc. 35

United Metallic "O" Ring Corp., Div. of United Aircraft Products, Inc... 121
United Shoe Machinery Corp..... 89
U. S. Chemical Milling Corp..... 123
U. S. Rubber Co., Mechanical Goods Div. 70

Valvair Corp. 42-43
Vellumoid Co. 110

Wagner Electric Corp..... 68
Warrick Co., Charles F..... 122
Weatherhead Co., The..... 88
Weckesser Co. 124
Westinghouse Air Brake Co., Industrial Products Div..... 131

PRODUCT ENGINEERING ADVERTISING SALES STAFF

Atlanta 3 . . . W. O. Crank, 1301 Rhodes-Haverty Bldg., Jackson 3-6951

Boston 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg., Hubbard 2-7160

Chicago 11 . . . Mid-Western Adv. Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N. Michigan Ave., Mohawk 4-5800

Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

Dallas 1 . . . R. T. Wood, 901 Vaughn Bldg., 1712 Commerce St., Riverside 7-5117

Denver 2 . . . John W. Patten, 1740 Broadway, Mile High Center, Alpine 5-2981

Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793

Los Angeles 17 . . . Robert Obenour, 1125 West 6th St., Madison 6-9351

New York 36 . . . B. K. Adams, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

Philadelphia 3 . . . D. G. Jones, K. S. Willadson, 6 Penn Center Plaza, Locust 8-4330

Pittsburgh 22 . . . C. F. Leveroni 1111 Oliver Bldg., Express 1-1314

St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES.... 125
Index to Advertisers begins on P 130
Products Index begins on P 128

Typical Control Functions solved by AIR CIRCUITRY

Westinghouse Multi-Position Cylinder

The Westinghouse Air Brake Company's complete line of AIR CIRCUITRY components contains a wide variety of pneumatic positioners to handle almost all of your force and positioning requirements.

No longer is pneumatic positioning limited to a single or double acting cylinder. Remotely controlled by directional and/or pressure control valves, both variable and fixed force and positioning is possible. Along with all the advantages of air, these devices are easily maintained and serviced. Uncomplicated and rugged, pneumatic positioners may be the answer to your control problems.

Typical Applications—The illustrated positioners have been used in almost every field of industry today. These positioners can:

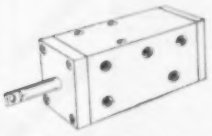
clamp	punch	snub	convey	push
rotate	lock	form	bend	blank
index	broach	crimp	cushion	pull
hold	squeeze	twist	stretch	eject
feed	shear	raise	brake	move
pierce	lower	press	turn	coin

If you have a positioning problem, let us know about it. It can probably be solved with AIR CIRCUITRY. For more information, ask for our catalog on Positioners.

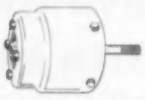
What is AIR CIRCUITRY?

This is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise AIR CIRCUITRY is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.

1. ONE AND TWO STATION POSITIONING—Single and double acting cylinders can perform all types of force and positioning functions. The Westinghouse line of cylinders includes diameters from 1" to 10"; strokes to suit application; single and double end; foot, swivel, flange and trunnion mounts.

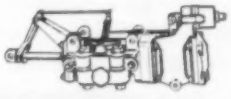


2. MULTI-STATION POSITIONING — Controlled by an associated directional valve, these cylinders attain 3, 4, 5 and 7 fixed positions of stroke. Three position cylinders are available in 2", 3", 4", 5" and 6" diameters. Strokes may be obtained to suit application.



3. VARIABLE FORCE AND POSITIONING — Diaphragm type cylinders are controlled by manually or mechanically operated pressure control valves to achieve a variable force or position of the rod. Various diaphragm areas and strokes available.

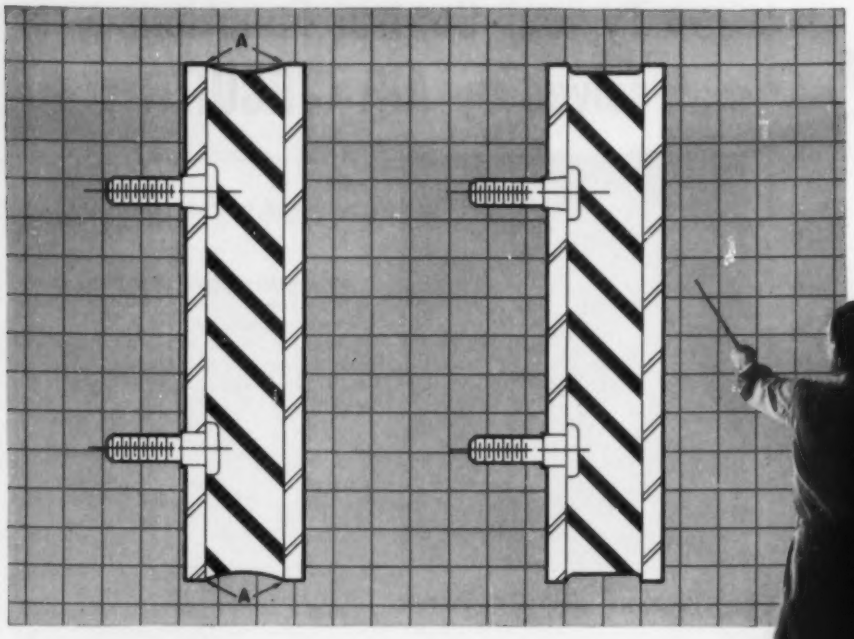
4. INFINITE POSITIONING-LIGHT—The actuator positioner has an infinite number of positions, governed by the amount of air pressure acting on its spring opposed diaphragm. Remotely operated pressure control valves dictate the position of the operated lever. This device has a low force rating.



5. INFINITE POSITIONING-HEAVY—The Westinghouse PNEUDYNE® Positioner can position accurately, independent of the opposing force, up to its power capacity. The power capacity is determined by piston size and supply pressure. Remotely controlled by pressure control valves, this device maintains its position throughout changes in the opposing force.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor

WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA



Savings in molded rubber parts begin with improved design

thru **ORCO**

CUSTOMEERING

Similar designs? Almost, but not quite. In the design at left, "A" is a stress point. The shrinkage of the rubber can cause concentrated strain at the edges of the bonded area. Ohio Rubber engineers would probably recommend the design shown at right.

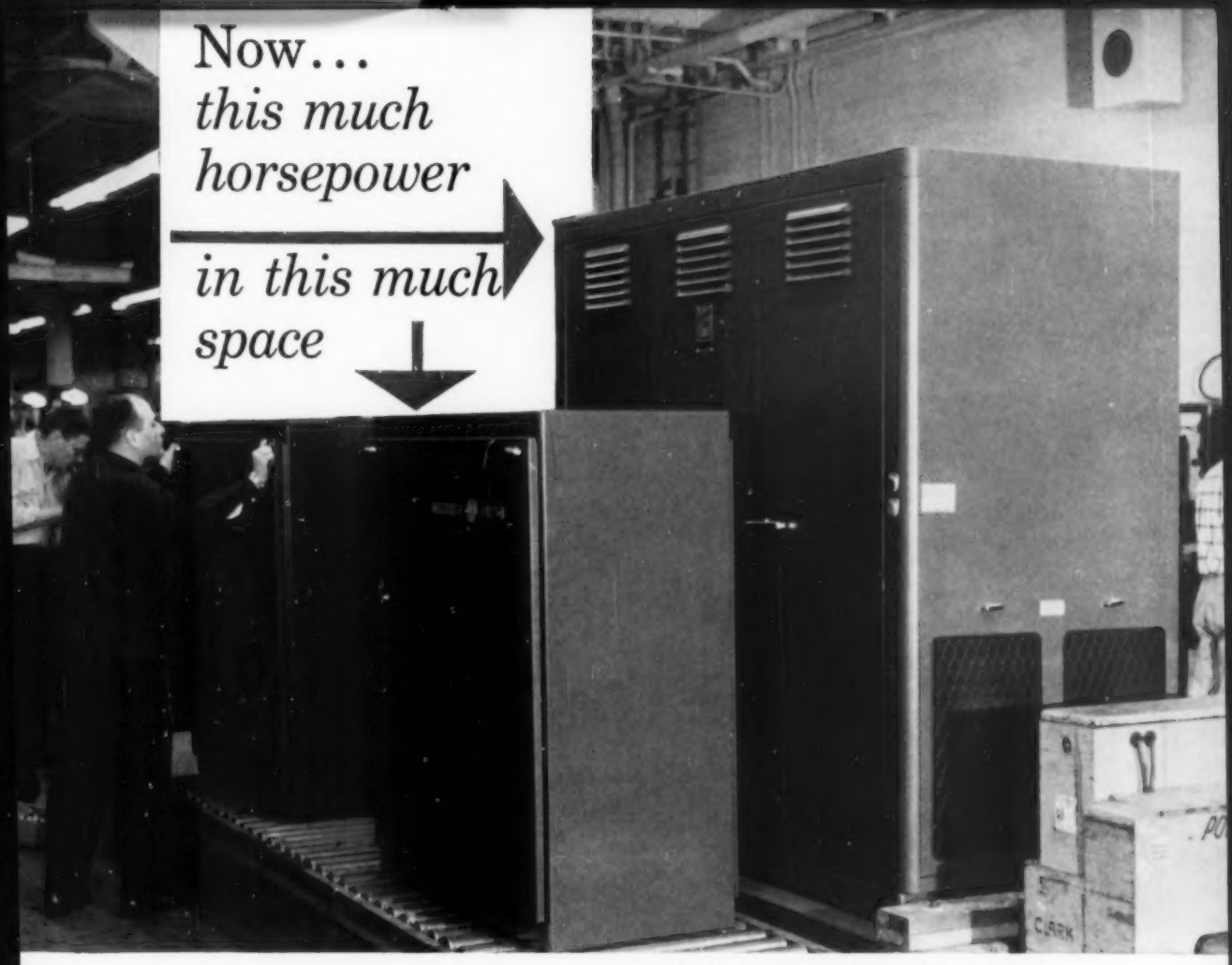
Attention to important details like this is typical of ORCO's "customeering" of parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, whether they be molded, extruded, or bonded to metal.

From components weighing less than a gram to parts of over 73 lbs., whatever the shape involved, ORCO's integrated research, design, electronically controlled compound mixing, and production facilities, assure component uniformity and quality to meet the most exacting requirements. Check with ORCO engineers on your next rubber or vinyl component problem. Your inquiry will receive prompt attention.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

THE OHIO RUBBER COMPANY

A Division of The Eagle-Picher Company
Willoughby, Ohio



New 50 hp. Super "T" V★S Control Units compared with 50 hp. old style drive on Reliance production line.

New Reliance SUPER 'T' V★S DRIVES put more power into a 35% smaller package

You can increase usable work space and improve machine performance with the New Reliance Super 'T' V★S Drive. More than just a compact drive, the Super 'T' packs extra punch into its new small size.

Like the Super 'T' Drive Motor, the new control unit uses Class B insulation, and will take repeated 100% overloads of one minute duration. These features plus special control apparatus design and the Super 'T' D-c. Drive Motor actually put more power in less space.

This systematic design balance of power unit, drive motor and controls forms a fast functioning drive to provide a wide range of variable operating speeds from a-c. circuits.

40—150 hp. Super 'T' V★S available for immediate delivery. Contact your Reliance Sales Engineer for delivery schedules of the complete line, 1—350 hp.

C-1628

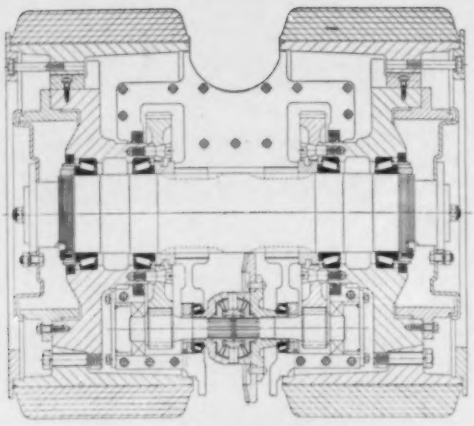
Product of the Reliance Electric and Engineering Company, manufacturers of a-c. motors, Master Gearmotors, Reeves Drives, Super 'T' D-c. Motors, generators, controls and engineered drive systems.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 307A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in principal cities

MASTER R REEVES

CIRCLE NO. 202 READER SERVICE CARD



How **YALE & TOWNE** uses Timken bearings in the drive wheels of its Model KH33GH127 lift truck to roll terrific loads, assure long life, cut maintenance.

WORLD'S HIGHEST CAPACITY LIFT TRUCK CARRIES 100 TONS ON 44 TIMKEN® BEARINGS

IT'S 21′4″ long, has a total weight of 77,000 lbs.! The platform measures 13′ by 8′. It's Yale & Towne's new Model KH33GH127 lift truck that provides 2′4″ of lift hydraulically. To take the tremendous loads (up to 100 tons), keep vital parts rolling smoothly, Yale & Towne uses 44 Timken® tapered roller bearings in the trail wheels, drive wheels, pinion and differential.

Timken bearings ask no favors when rolling big loads. Full-line contact between their rollers and races provides extra load-carrying capacity. The tapered construction of Timken bearings lets them take both radial and thrust loads in all combinations. And rollers and races are case-carburized to produce hard, wear-resistant surfaces over tough, shock-resistant cores.

Timken bearings practically eliminate friction. They're geometrically designed and precision-made to have true rolling motion. They *roll* the loads—help any machine operate smoother and longer with minimum maintenance. And they normally last the life of the machine.

For extra quality control, we even make our own electric furnace fine alloy steel. Timken bearings help any machine run better. And better machines make better products—do better work. That's Better-ness. Look for the trade-mark "TIMKEN". It's your symbol of Better-ness. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.

This symbol on a product means its bearings are the best.

BETTER-ness rolls on **TIMKEN**® tapered roller bearings

CIRCLE NO. 203 READER SERVICE CARD